



5 FUN, AFFORDABLE NEW COUPES!

TOP 10 TECH BREAKTHROUGHS FOR 2012

Popular Mechanics

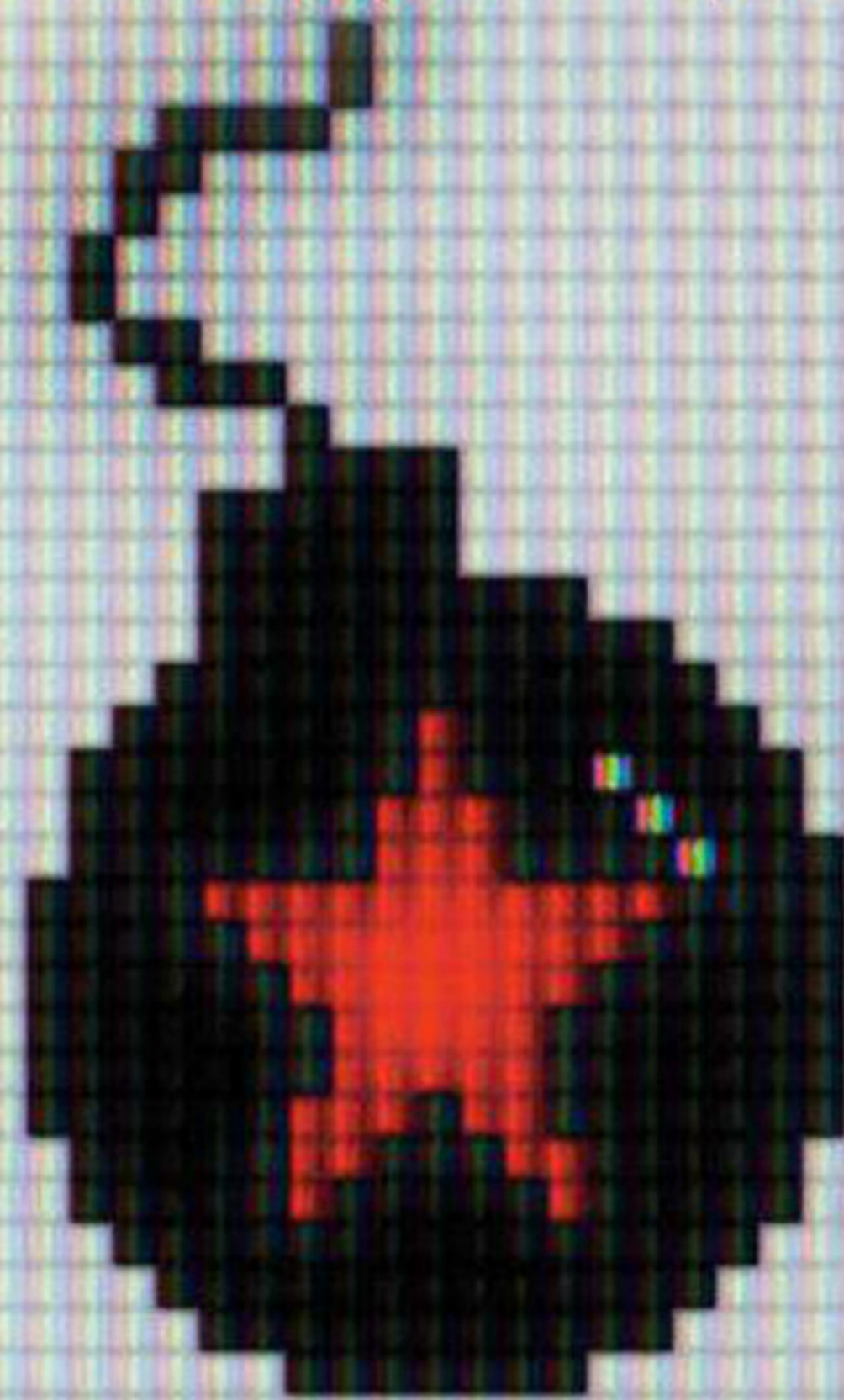
**THE
MOST
(AND LEAST)
ACCURATE
SCI-FI FILMS
EVER**
p.58

Science Technology Automotive Home Adventure

PopularMechanics.com January 2012

DIGITAL SPIES

HOW CHINA'S
SECRET WAR
THREATENS
OUR ECONOMY,
NATIONAL
SECURITY
—AND YOU



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ODYSSEY

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October 4, 2011

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PopMech Jan.

COVER STORY

52 The Secret War

Foreign spies are hacking the computers of major U.S. companies, stealing billions in industry secrets and technology. PM explores the dark world of digital espionage that threatens our economy, our national security, and even our personal privacy.

BY ADAM PIORE

58 Strangers in a Strange Land

After decades of twisting reality at will, sci-fi screenwriters are switching up the formula and integrating more real science into the genre. **Plus:** PM's highly subjective list of the most (and least) accurate sci-fi flicks. BY DAVID KUSHNER

64 The Outsiders

Pulling away from typical automotive segments, several new rides promise to kick boring like a bad driving habit with innovative takes on size, shape, and power. We leave our preconceived notions at the curb and put five spunky "not sedans" to the test.

BY BEN STEWART

70 Steel & Snow Able to scale steep terrain and take on deep powder, the mountain snowmobile is adrenaline on tracks. Some skiers hate the machine, while others put it to good use. PM heads to Wyoming for a frigid dose of the latest trend in winter adventure. BY JERRY BEILINSON

The Polaris 800 Pro-RMK snowmobile with an aftermarket BoonDocker turbo gets you major air time—if you have skills like rider Dan Adams's.

On
the
cover

It's not all-out war—yet. Digital spies, the majority reportedly in China, are tapping into our nation's most sensitive information in attacks that could compromise the security of everyone online. **Illustration by Nathan Fariss.**

PHOTOGRAPH BY DAVID STUBBS

Tech Watch

11 Reno Air Race Crash Eleven fatalities put air-show safety in the spotlight. **Plus:** A massive sunken-treasure discovery, video created by the human mind, and super-efficient deep-sea wind turbines.

Upgrade

21 Out With the Old Three demolition tools to make way for the New Year. **Plus:** Wireless speakers undergo the PM Abusive Lab Test, how to put kitchen waste in its place, and 10 gadgets get rated.

New Cars

31 Frisky Fisker The 2012 Fisker Karma isn't just a fast luxury sedan. It's a fast luxury sedan that plugs in. **Plus:** BMW's 2013 M5; looking into the future at the Frankfurt Motor Show.

50 Long-Term Test Cars The Kia Sorento SX joins our test-car stable, and the Jeep Grand Cherokee Overland hits the logging trails.

Gadgets may be expensive, but the tools to keep them clean don't have to be. Most cost less than a cup of coffee.

You don't need a microscope to know that gadgets are filth magnets. But one recent study found that 92 percent of cellphones were contaminated with potentially harmful bacteria. — DIGITAL CLINIC, PAGE 80

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43 The College Bubble With tuition costs and institutional debt on the rise, Glenn Harlan Reynolds takes a hard look at the value of a college education.

46 10 Tech Terms for 2012 PM rounds up the computing, medical, and transportation tech concepts of today and tomorrow into one tidy cheat sheet.

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PopMech
diy

Tech

77 Removing Yourself From the Internet How to regain control of—or even erase, if so desired—your online identity, one bit of personal information at a time.

80 Digital Clinic Clean your gadgets without damaging them—and without spending a fortune. **Plus:** Fix odd-looking motion on your TV.



Home

83 Simply Perfect A little two-door cabinet gives big, with loads of storage room and smart looks.

86 Homeowners Clinic How to put a wobbly chair on firm footing. **Plus:** Two surefire ways to remove stubborn rocks from the yard.

90 PM Saturday Our DIY industrial lamp withstands all sorts of shop abuse but turns on with just a touch.



Auto

93 Running on (Natural) Gas Switching from gasoline power is easy, but is it worth the expense?

97 Car Clinic How to rotate tires without messing up the pressure-monitoring system. **Plus:** Wipe away greasy interior buildup, and more.

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PHOTOGRAPH BY DEVON JARVIS

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TOP 10 MOVIE CARS Our list of the most memorable cars in cinematic history includes 007's Aston Martin DB5, the 1968 Ford Mustang from *Bullitt*, and the Batmobile from Christopher Nolan's Batman films. See if your favorite made the lineup.

popularmechanics.com/moviecars



LASER WEAPONS We catch up with eight new military laser technologies, such as the plane-mounted version above, to see which ones are close to becoming battlefield-ready—and which are still sci-fi.

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FIX IT BEFORE IT BREAKS Crumbling masonry, stubborn sliding doors, cracks in the driveway—your home is full of little problems that could soon become big ones and require major repairs. Make these fixes now and spare yourself huge headaches later.

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PM BREAKTHROUGH
AWARDS UPDATECatching Up With
Greg Schroll

CARBIDE ROBOTICS



Greg Schroll won a PM Breakthrough Award in 2009 for his remote-control robotic ball driven by internal gyroscopes. He said he dreamed of air-dropping 1000 of the bots into some forbidden zone, where "they'd bounce and start collecting information." As unlikely as that may sound, Schroll is now working on improvements that show the bot's potential to scour such places as hazardous waste sites, war zones, or even somewhere out of this world. — ALLIE HAAKE

PM: Your focus has changed since building your first robot. How so?

GS: Our focus was on a much smaller ball. Now we're applying what we learned in 2010 to build larger gyroscopes that work in wheeled or track vehicles, or in legged and bipedal robots. We're developing a technology that could be applied to a product.

PM: How has the development process been going?

GS: It's rigorous. We've been doing dynamic computer modeling, but that doesn't really tell you how the device will fail. So we built a containment vessel out of concrete and steel rebar with a bullet-resistant window, and we're trying to spin the flywheel as fast as possible, until it explodes. We need to know how fast we can spin these things. The next step is getting funding. Our ultimate goal is appealing to someone in the military—or even at NASA—who's interested in using the technology in their systems.

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PM LETTERS

Mac vs PC: The Debate Goes On

Thanks for the story "PM Lab Test: Mac vs PC" (November) comparing the two computers. As a technician who works on both, I think you should consider maintenance and repair costs in this type of review. For instance, when a PC battery goes bad, you just swap in a new one. But replacing the battery on a MacBook Pro requires disassembly, a difficult task that forces most people to pay an Apple dealer to get the job done. Also, Mac users face excessive price markups on upgrades. Don't get me wrong, Macs are good for what they do—but upkeep can be costly.

JARRETT S. WARNER WARNER ROBINS, GA

For years, I've felt that Macs and PCs are more similar than different. But the beauty of the PC is the range of choices—styles, components, price points. So why the Pavilion DM4 PC for the comparison tests? There are some interesting differences in DM4 competitors that could turn the tests around. For example, the Toshiba Satellite E205 is a hot rod in certain tests compared with the DM4. The point is, there's choice, choice, choice. That's the beauty of the PC—and at significant savings over a comparable Mac.

RICK USACK KENT, WA

Private Space Fanfare

I was thrilled to see the SpaceX Dragon capsule and Falcon 9 rocket on November's "20 Bold Ideas" cover. However, my space balloon popped when I found a mere one-pager within the huge 2011 Breakthrough Awards feature. Please, give us more SpaceX! And while you're at it, more Sierra Nevada Corp., Bigelow Aerospace, Armadillo Aerospace, and Virgin Galactic. Space exploration isn't just for governments and military contractors anymore. It's for all of us.

DAVE DRESSLER OCEANSIDE, CA

EDITOR'S NOTE: We agree completely. The rise of private spaceflight is a thrilling, ever-changing adventure story. We've reported on SpaceX before—from September 2009's "The Rocket Men" to the May 2011 cover story, "The Early Adopter's Guide to Space

PopMech

Send a hi-res photo of yourself with the latest issue (plus your name, city, and state, and a short note about why you love PM) to popularmechanics@hearst.com. See some of our favorites at popularmechanics.com/readerphotos.

PM reader Dave Forney of Greencastle, Pa., lives a life that would knock your socks off. Good thing it doesn't knock his socks off, or he'd have less protection against hungry leeches. Forney is an MAF International medevac bush pilot in Borneo, Indonesia. But each year, he sets out with a friend on a trek through some of the most remote jungles on earth. "We do it to experience life and travel without the technological marvel that we pilot every day—the airplane," Forney says. One thing he doesn't travel without: his favorite reading material. "Each night, by the light of my tiny LED headlamp, I curl up in my hammock and catch up on the latest in science, gadgets, and news from PM."



Travel"—and we'll keep a close eye on private space companies as they continue to make aerospace history. Check out popularmechanics.com for the latest, including a detailed look at the ongoing battle over the level of NASA control of spacecraft designs.

THE EDITORS, POPULAR MECHANICS

All Revved Up

You left out an excellent car in your story "Steal This Car . . . For the Price of a

Loaded Camry" (November). The Mitsubishi 3000GT VR-4, produced from 1991 to 1999, is the same price or less than the cars you featured, and most come with a twin-turbo V-6 engine, leather seats, active suspension, all-wheel drive, and a five-gear manual transmission. The car handles well in corners, does 0 to 60 in 5.5 seconds, and has a top speed of 155 mph. It would have fit well in your article!

BRETT MILLIKEN FORT COLLINS, CO

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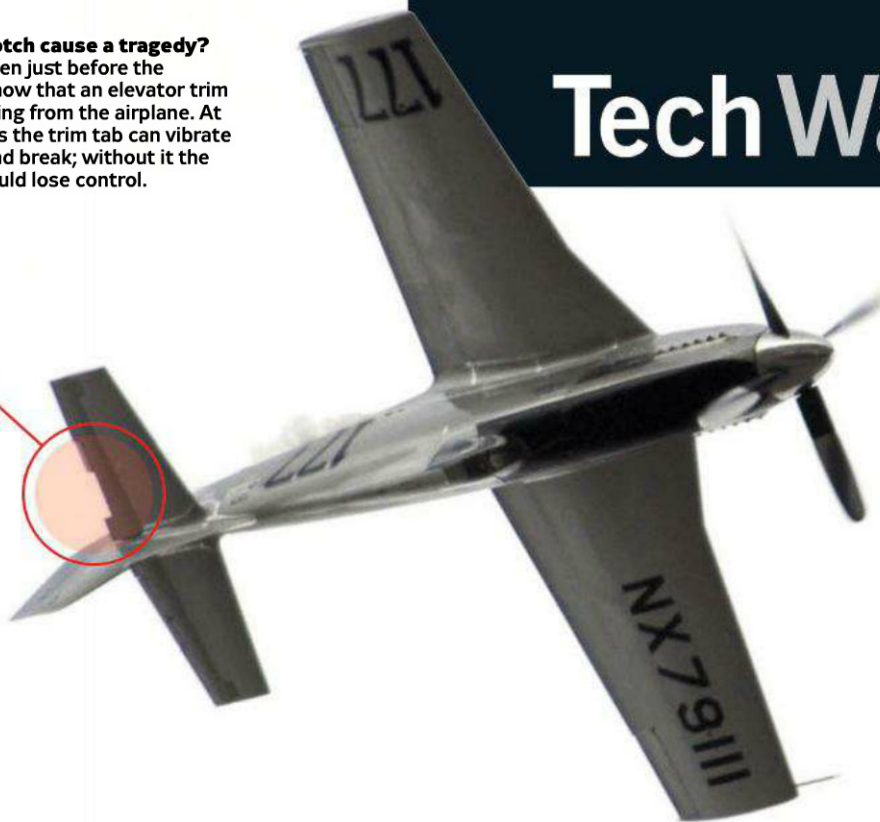
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Tech Watch

Did this notch cause a tragedy?
Photos taken just before the accident show that an elevator trim tab is missing from the airplane. At high speeds the trim tab can vibrate violently and break; without it the airplane could lose control.



WHAT WENT WRONG:

Reno Air Race Crash

AFTER A MIDAIR MALFUNCTION LED TO MULTIPLE FATALITIES, PM EXPLORES WHETHER SAFETY CHANGES CAN SAVE AIR RACING. BY JEFF WISE

The crowd gasps as the wayward air-race plane banks ominously toward the viewing stands. Moments later, the 6-ton World War II P-51D fighter plummets to the ground, killing 10 spectators and pilot Jimmy Leeward and injuring 74. The crash on Sept. 16 at the National Championship Air Races in Reno, Nev., threw the future of the 47-year-old competition into question.

Leeward's heavily modified P-51, *The Galloping Ghost*, failed while traveling at nearly 500 mph, far faster than it was originally designed to go. The aircraft's nose suddenly pitched upward, the motion causing a spike in g-forces. This could have been enough to cause Leeward to black out; he is not visible in the

cockpit in the video of the incident. The airplane then rolled and dove toward the ground at full power.

Photos and video of the tragedy also indicate a possible cause: Part of the tail called an elevator trim tab, which helps stabilize the aircraft, is missing. If that part broke off, it could have caused the plane to lurch into a vertical climb.

No matter the cause, the air races at Reno are now facing scrutiny. "It doesn't take a rocket scientist to see that with the planes so close, there's a possibility of danger," says Andy Chiavetta, a mechanic on one of the planes competing that day. "In the pits, we all know that there's risk, and so do 95 percent of the people in the stands. It's a part of racing."

NEXT: HOW AIR RACING CAN BE SAFER →



Movie stunt pilot Jimmy Leeward, the 74-year-old who flew *The Galloping Ghost*, was a favorite at the venerable air races at Reno.

Saving Reno

AIR RACES THRIVE ON VIEWERS WATCHING AIRPLANES FLYING NEARBY AT HUNDREDS OF MILES PER HOUR. FINDING THE BALANCE BETWEEN ENTERTAINMENT AND RISK WILL BE VITAL TO CONTINUING THE AIR RACES AT RENO.

After the National Transportation Safety Board issues its report on the *Gallop* crash later this year, the FAA may change its air-race requirements. But every possible fix has a drawback—after all, fans come to watch airplanes roar past at close range.

Move the viewing stands to inside the course.

PRO: Debris shed from damaged planes would tend to fly away from the crowd, not into it.

CON: Pilots in planes with mechanical problems would have to fly over the crowd to reach the runway.

Lengthen the straightaway.

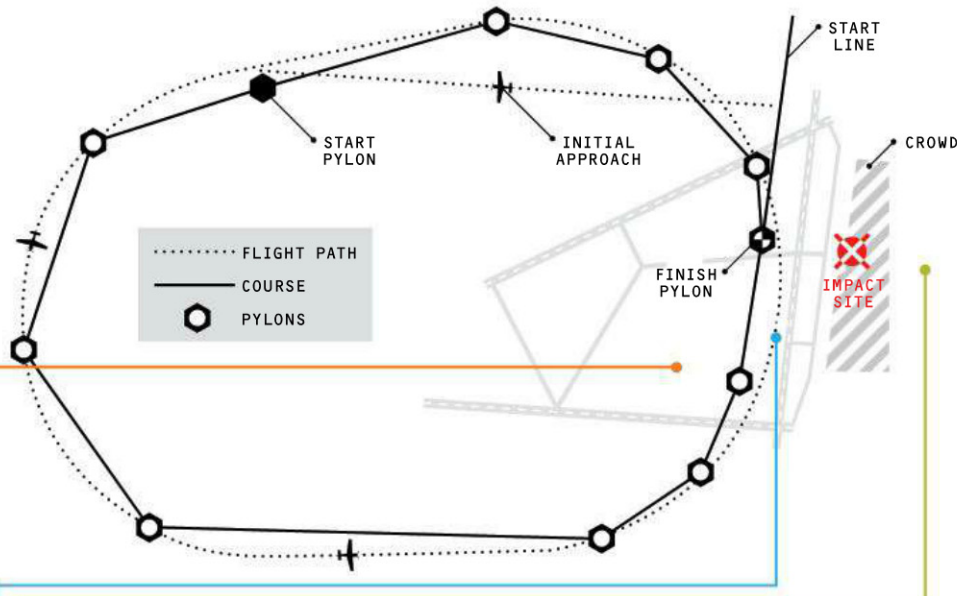
PRO: Would move spectators farther from the zones near turns, the area with the greatest lethal potential.

CON: There's not much room at Reno; the course is constrained by mountains and residential development.

Move the viewing stands back from the course.

PRO: This is the most likely solution, as this distance is the key parameter that the FAA sets for air-race and air-show spectator safety.

CON: Putting more distance between fans and the action risks diluting the excitement.



The moment of disaster: Sept. 16, 2011

Between the start of the Reno air races in 1964 and 2010, 19 people lost their lives. Last year's crash was the first that hurt or killed spectators. Here are some notable fatalities:

1972 H. E. Thomas crashes a homebuilt biplane; the NTSB never determines the cause.

1975 Pilot M. D. Washburn dies after his wing clips a pylon and he crashes. About 15 minutes later, wing walker Gordon McCollom is killed when his head hits the ground during a stunt.

1994 Bill Speer, flying a P-51D, crashes while pulling off the racecourse after his windscreens are obscured by oil leaking from the propeller. Six days later, another pilot dies after a collision at the start of a race.

1999 The tail of a P-51R disintegrates while in flight, killing pilot Gary Levitz and damaging a house. No one on the ground is injured.

2002 Tommy Rose crashes his homebuilt airplane into the ground at 380 mph. The NTSB states that the airplane's horizontal stabilizers failed due to excessive speed.

Are FAA Standards Sufficient?

→ The FAA mandates that spectators watching high-speed maneuvers be set back from the race line by at least 1500 feet. That distance is based on scatter diagrams that calculate where debris would land if pieces came off a plane on the course. But no FAA precaution takes into account what occurred at Reno, an aircraft leaving the course intact and flying into the crowd, 1900 feet away.

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Sweater Weather on Mars

A

4-billion-year-old rock from Mars, likely blasted into space by a meteor, holds the first measurable evidence that the Red Planet had liquid water. Studying the bonds between rare isotopes of carbon and oxygen found in the rock, scientists at the California Institute of Technology in Pasadena determined that the elements had combined at about 64 F in an environment with liquid water.

— ALEX HUTCHINSON



This rock has a story to tell. Heavy isotopes of carbon and oxygen bonded together in the presence of water, and at a moderate temperature.

• QUICK HITS



I'VE SEEN A DOUBLE RAINBOW. COULD I EVER SEE A TRIPLE?

Double rainbows are fairly common: A second arc is produced by light reflecting twice between the inner walls of raindrops before exiting. Scientists have long assumed that a third arc would be too faint to see. But new calculations by Naval Academy meteorology professor Raymond Lee suggest that a triple rainbow could be visible under certain conditions—about 40 degrees from the sun when it's peeking through dark clouds. Armed with this information, rainbow chasers in Germany snapped the first-ever photographs showing a triple rainbow.

TECH WATCH



Just Say No—to Cancer

CAN A CLUB DRUG ROLL OVER A DEADLY DISEASE? BY AMIR KHAN

Researchers from the University of Birmingham in England have found a new weapon to fight cancer—Ecstasy. “We found that blood cancer cells make the same proteins that are targeted by Ecstasy in the brain,” says John Gordon, a professor of cellular immunology. “We reasoned that if they have these proteins on them, then Ecstasy might affect them in some way. We found that at very high doses the drug was able to kill some of them.” Gordon used a modified form of Ecstasy that is stronger but less toxic than the club drug. “The new form of Ecstasy gets inside the blood cancer cells more easily,” Gordon says. He adds that even though the psychoactive effects of the drug are reduced, he still isn’t sure of the long-term side effects. “We now need to go through testing to see whether the new drugs work in the body as well as they do in the test tube,” he says.



Silver Shipwrecks

Treasure hunters have located two wrecks in international waters off the coast of Ireland—and more than \$200 million in silver they are believed to have been carrying. Tampa, Fla.-based Odyssey Marine Exploration pinpointed the vessels using an MAK-1M sonar scanner towed several miles below the surface; remotely operated subs were later deployed to confirm the wrecks’ identities. The SS *Gairsoppa*, a 412-foot-long British cargo ship torpedoed by the Germans in 1941, held the majority of the loot, an estimated 7 million ounces of silver. The 450-foot SS *Mantola*, sunk in 1917, is believed to have contained another 600,000 ounces of silver. Robotic salvage missions will begin in mid-2012; the company and the British government will share the profits 80/20, respectively. —A.H.



The eye sees: A scene from a Steve Martin movie.
Reconstructed image: Researchers record brain activity and match it with a video database, producing a human form with something around his neck.



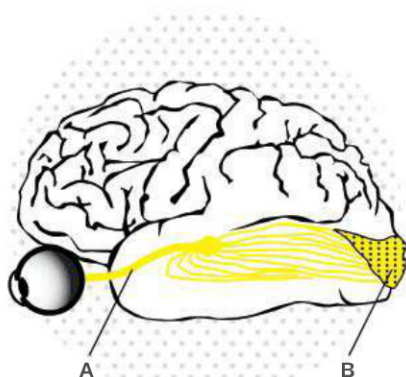
The eye sees: An airplane in flight, and foliage in the foreground.
Reconstructed image: A match of brain activity and database videos shows a horizontal shape, a blue backdrop, and darkening on the right.



Video on the Brain

TAKING STRIDES TOWARD UNDERSTANDING HOW THE BRAIN PROCESSES STIMULI TO RECOGNIZE IMAGES, RESEARCHERS FIGURE OUT HOW TO PROJECT NEURAL ACTIVITY ONTO A TV SCREEN.

BY STEVE ROUSSEAU



Images are transmitted to the brain via each eye's optic nerve.

A These signals are first processed in the primary visual cortex.

B Scientists examine the primary visual cortex to produce images from brain activity.

HOW DO THEY DO IT?

UC Berkeley professor Jack Gallant and his team use MRI to track blood-flow changes in a subject's primary visual cortex—the brain's largest visual processing center—as he or she watches a movie. The researchers then create a model of the visual cortex that matches the blood-flow pattern with the images the subject is viewing. Algorithms are applied to compare the brain signals with a catalog of about 5000 hours of YouTube video. The images that most accurately correspond to the brain activity are compiled into a composite video, which resembles the YouTube footage.

"I think it's very impressive that they can get these admit-

tedly crude re-creations of our internal representations of video," says Marcel Just, director of the Carnegie Mellon University Center for Cognitive Brain Imaging, who was not involved in the study.

WHAT'S IT GOOD FOR?

Such brain-visual linkages could one day aid communication with stroke or coma patients. Gallant says that after his team's technique is refined, it could also record and play back dreams. The obstacle to this is understanding how the brain's visual processing changes when a person is sleeping or awake. Gallant is confident this will happen. "It's only a matter of time," he says.



LASER BOMB DETECTION ➔ The best place to be when searching for concealed bombs is as far away as possible. A system developed by Michigan State University chemists, with support from the Department of Homeland Security, uses a femtosecond laser that vibrates molecules with ultrashort pulses and identifies them with longer ones. The laser is no more powerful than a presentation pointer, but new studies show that the system could detect multiple chemical signatures in real-world surroundings.



TWO SUNS ARE BETTER THAN ONE ➔ Astronomers call it a circumbinary planet; *Star Wars* fans are calling it Tatooine, after the Skywalkers' home planet. SETI Institute researchers, using data from NASA's Kepler space telescope, found a planet about 200 light-years from Earth that is orbiting two stars, the first of its kind confirmed. Periodic dips in the stars' brightness allowed astronomers to calculate that a planet about the size of Saturn completes an orbit of the two-star system every 229 days.

ROAD SCIENCE



Shine On → LEDs quickly became the luxury-car headlight of choice after Audi adopted them in 2007. Now BMW is one-upping the competition with *headlamps that use lasers 1000 times as intense and twice as efficient as LEDs*. To be safe for human eyes, the blue beams are converted into white light by yellow phosphor. BMW equipped its 2011 i8 concept car with the laser lights and will likely use them in select models over the next few years.

— ANDREW DEL-COLLE

ECONOMIC INFRASTRUCTURE

Turning Milliseconds Into Millions

HIGH-SPEED FINANCIAL TRADING GETS EVEN FASTER WITH A NEW TRANSATLANTIC CABLE.

BY JOE PAPPALARDO

➔ **The newest fiberoptic cable** crossing the Atlantic won't carry voice or Internet data. Instead, the line from New York to London will beam financial information to money marketers and hedge-fund traders—5 milliseconds faster than rival lines. "If you are trading in one market, you

want to be monitoring what's happening in the other markets," says Bjarni Thorvardarson, CEO of Hibernia Atlantic, the firm installing the cable. "And if you know that 5 milliseconds faster or sooner than somebody else, you have a big leg up."

In this day of automated, high-frequency trading, algorithms automatically execute sales and purchases based on triggers in financial data. Regardless of a trader's investment strategy, his or her software often reacts to the same economic data. And as always in the world of trading, the first orders on the books are the first ones executed. With a split-second advantage,

a trader's order can jump to the head of the line, before prices change as more algorithms place similar orders.

Congress and market regulators are becoming leery of automated trading. "The SEC doesn't have the technology to understand if high-frequency trading is legitimate or if it's manipulative," says Larry Tabb, CEO of the TABB Group capital market research firm.

Thorvardarson says his customers aren't worried. "To be better than the competition—that's what competition is about," he says. The route survey should be finished early in 2012; the \$300 million cable will be ready for service in 2013.



3741 MILES

Total length of the new Hibernian Express cable.

310 MILES

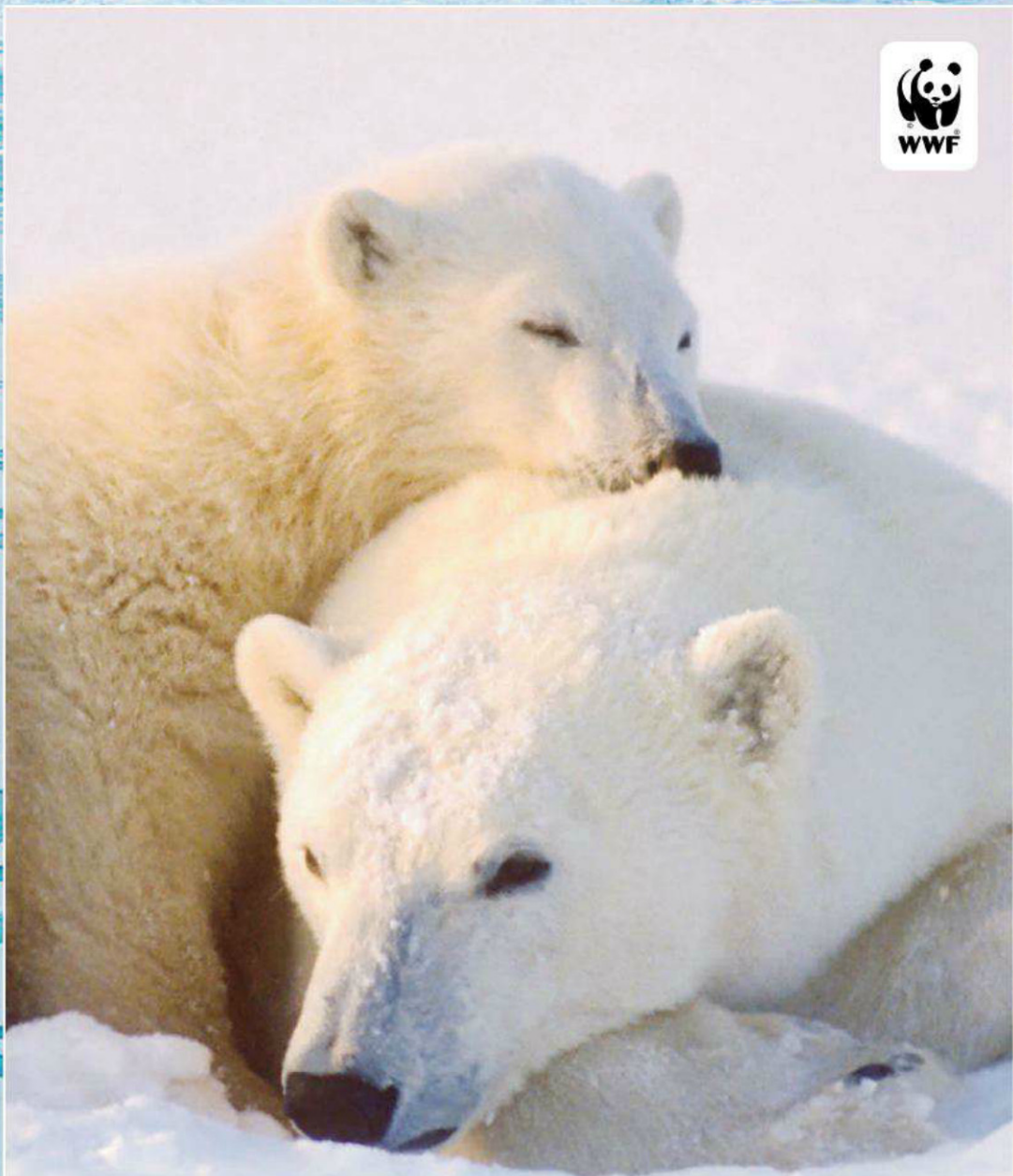
The planned transatlantic cable will be this much shorter than existing lines, making its transmission rate 5 milliseconds faster.

62 MILES

Distance that light in a submarine fiberoptic line travels in about 1 millisecond.

The survey ship at left is currently scouting every inch of the planned route by pulling along a sonar scanner 30 feet above the ocean floor. The instrument details the makeup of the bottom, which ranges from sharp rocks to soft clay; this determines the toughness of cable to be laid in a given stretch. In shallow water—anything less than 3280 feet deep—the cable must be buried 10 feet to protect it from commercial fishing trawls.





Protecting the Future of Nature



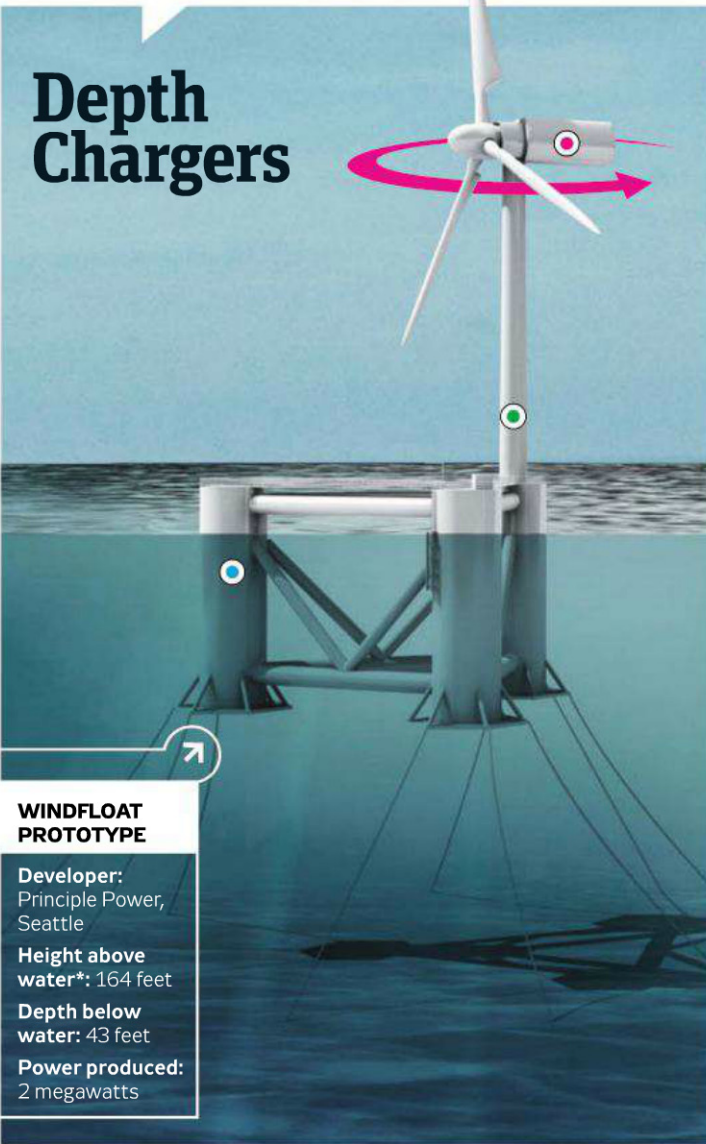
Arctic sea ice, a critical habitat for polar bears, is vanishing before our eyes. As polar bears are forced to spend more time on land, the potential for conflict between humans and bears grows. WWF creates global solutions to cut carbon emissions—a leading cause of the depletion of sea ice—while also working with local communities, scientists and governments in Alaska and Russia to reduce the threats to polar bears. We can protect the needs of polar bears while respecting the needs of local communities.

Be Part of Our Work

worldwildlife.org

• ALTERNATIVE ENERGY

Depth Chargers



WINDFLOAT PROTOTYPE

Developer:
Principle Power,
Seattle

**Height above
water*:** 164 feet

**Depth below
water:** 43 feet

Power produced:
2 megawatts

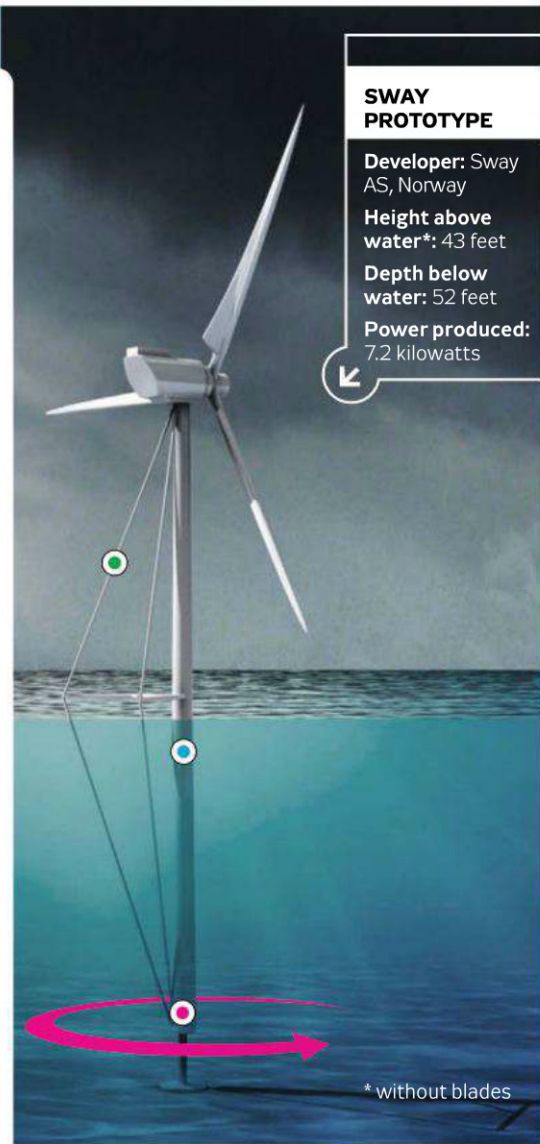
SWAY PROTOTYPE

Developer: Sway
AS, Norway

**Height above
water*:** 43 feet

**Depth below
water:** 52 feet

Power produced:
7.2 kilowatts



* without blades

The airstream 20 miles offshore blows at an average 33 feet per second, a prime condition for wind turbines. But it's prohibitively expensive to build a turbine in deep water, and the ocean floor that far off most of the coastal United States is a long way down. Two companies are testing floating turbine prototypes in Europe that are designed to operate at great depths and at low cost. Officials with the Department of Energy are evaluating both real-world tests for domestic use. — STEPHANIE WARREN

STABILITY

WindFloat's base **adjusts the water level in three columns** to keep the turbine level. Engineers designed Sway's tall, slender tower so that **its center of gravity lies below the structure's center of buoyancy**, allowing it to remain steady even when seas are turbulent.

AFFORDABILITY

WindFloat saves steel by **placing its tower on a column** instead of on a platform. The Sway design economizes and **gains structural support with steel cables**. Its blades are mounted downwind—the opposite of most turbines—to keep them clear of the cables.

ROTATION

WindFloat's 100-ton nacelle, or gear housing, **turns to meet the breeze**, like a typical land-based turbine. The Sway's **entire tower rotates** on a universal joint that connects the turbine to the tension-leg anchor; the blade clearance from the wires remains constant.

ESCORT
DRIVE SMARTER™



NEW

Introducing **ESCORT Live!**

The Ultimate Live Alert Network

"This is the ultimate
laser defense"

ESCORT
((Live!))

"Escort Live...
Game. Set. Match."

Laser Speed Monitoring

Live Laser Ahead

Introducing the ultimate real-time ticket protection network—**ESCORT Live!** This exclusive network provides instant communications between you and other ESCORT detector owners of high risk ticket situations. Imagine millions of other scouts helping you Drive Smarter.

Simply replace the power cord on your 8500 X50, 9500ix or RedLine detector, with our new SmartCord Live, download our app to your smartphone* and get instant access to the most powerful ticket protection network imaginable!

ESCORT Live! also provides an incredible new display on your smartphone with live traffic capability. Call or click for details.

Equipped with
SmartCord™ Live



Map
View

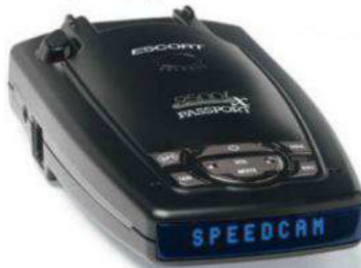


Dashboard View

Get the ultimate ticket protection by purchasing a new detector equipped with ESCORT Live!



New PASSPORT 8500 X50



Ultimate PASSPORT 9500ix



Revolutionary SmartCord Live



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Savings**

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Department PMECH

* ESCORT Live is compatible with iPhone 3GS or 4 using OS 4.1 or later and Android OS 2.1 or later. Subscription may apply. ©2011 ESCORT Inc.

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FEATURED EXPANSION ACCESSORIES





Upgrade

FuBar®
55-134
STANLEY®

Stanley's new FuBar adds a hatchet blade to its demolition repertoire.

Out With the Old

Kazoos, countdowns, and corks a-popping are fine, but we prefer some new noises this New Year's. A jigsaw chattering, yanked nails squealing—these are sounds of old acquaintance being forgot. Here, we present tools for bidding farewell to a wall, creating a functional void in raw lumber, or organizing the discards of the day. It's the upside of disposal, making way for something new and better. — HARRY SAWYERS



WATCH OUT, WALLS

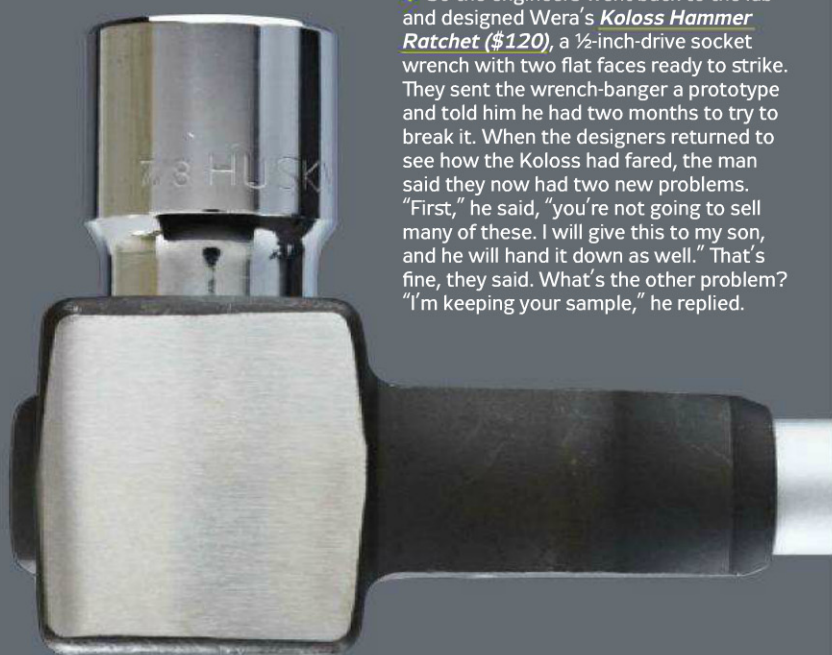
→ Stanley's first Functional Utility Bar merged a hammer and a pry bar; now the fourth generation of this hand-tool hodgepodge adds a hatchet to the mix. The **FuBar (\$20)** can dismantle drywall with a chop from that P-shaped blade. A face opposite the cutting end is designed to be struck, if the tool needs a hammer to help it along. Like its predecessors, the FuBar's cocked chisel tip can pry apart studs or molding, and a cat's paw and nail puller come in from odd angles to yank out cramped or buried fasteners. The main drawback is the short handle's lack of leverage. And it is just a hand tool—there's some stuff only a recip saw can set free.

"One customer returned six busted socket wrenches, so our engineers went to his house. They found him, this 7-foot-tall guy, swinging his wrench like a hammer. They asked what he was doing with the tool. 'What?' he asked. 'I just use it.'"

— IAN PARKHILL, PRESIDENT, WERA TOOLS

MEET THE SUPER SOCKET

→ So the engineers went back to the lab and designed Wera's **Koloss Hammer Ratchet (\$120)**, a ½-inch-drive socket wrench with two flat faces ready to strike. They sent the wrench-banger a prototype and told him he had two months to try to break it. When the designers returned to see how the Koloss had fared, the man said they now had two new problems. "First," he said, "you're not going to sell many of these. I will give this to my son, and he will hand it down as well." That's fine, they said. What's the other problem? "I'm keeping your sample," he replied.



HYBRID JIGSAW

→ European carpenters favor a fat barrel grip on a jigsaw, but U.S. craftsmen prefer a D-handle. Milwaukee's new **M12 Cordless High Performance Jig Saw (\$149)** combines the blade-steering control of a barrel with the skinny trigger grip of a D-style. The 4.1-pound cutter is compact too—at just 8.75 inches long, the 12-volt tool is one of the smallest ¾-inch-stroke saws on the market. Use it to notch flooring to fit radiator pipes or to trim MDF to make a countertop base.

Very high triglycerides is a medical
term for something serious:

TOO MUCH FAT IN YOUR BLOOD.

Ask your doctor about the FDA-approved medication made from omega-3 fish oil: LOVAZA

If you have high cholesterol, diabetes or are overweight, you may also be at risk for very high triglycerides (≥ 500 mg/dL), which is a serious medical condition. There's only one FDA-approved medication for treating very high triglycerides that's made from omega-3 fish oil. LOVAZA, along with diet, has been clinically proven to lower very high triglycerides in adults. Individual results may vary. LOVAZA has not been shown to prevent heart attacks or strokes. LOVAZA is only available by prescription. You can't get it at a health food store. So if you think you might have very high triglycerides, talk to your doctor about getting tested and ask about LOVAZA.

LOVAZA is used along with a low-fat and low-cholesterol diet to lower very high triglycerides (fats) in your blood. Before taking LOVAZA, talk to your healthcare provider about how you can lower high blood fats by losing weight, if you are overweight, increasing physical exercise, lowering alcohol use, treating diseases such as diabetes and low thyroid (hypothyroidism), and adjusting the dose or changing other medicines that raise triglyceride levels such as certain blood pressure medicines and estrogens.

IMPORTANT SAFETY INFORMATION FOR LOVAZA

Tell your doctor if you are allergic to fish or shellfish as LOVAZA may not be right for you. Talk to your doctor about any medical conditions you have and any medications you are taking, especially those that may increase your risk of bleeding. In some patients, LDL (bad) cholesterol may increase. Your healthcare provider should do blood tests before and during treatment with LOVAZA to check your cholesterol and triglyceride levels. If you have liver disease, you may require additional monitoring. Possible side effects include burping, upset stomach, and change in sense of taste.

How supplied: 1-gram capsule

Please see important Patient Information on the next page.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

For more information, visit LOVAZA.com or call 1-877-LOVAZA1



Capsule shown not actual size

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gsk GlaxoSmithKline

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or call 1-866-GSK-FOR-4U (1-866-475-3678)

LOVAZA[®]
omega-3-acid ethyl esters

PATIENT INFORMATION
LOVAZA® (lō-vā-zā)
(omega-3-acid ethyl
esters) Capsules

LOVAZA
omega-3-acid ethyl esters

Read the Patient Information that comes with LOVAZA before you start taking it, and each time you get a refill. There may be new information. This leaflet summarizes the most important information about LOVAZA and does not take the place of talking with your doctor about your condition or treatment.

For more information, visit
LOVAZA.com or call 1-877-LOVAZA1

What is LOVAZA?

LOVAZA is a prescription medicine, called a lipid-regulating medicine, for adults. LOVAZA is made of omega-3 fatty acids from oils of fish, such as salmon and mackerel. Omega-3 fatty acids are substances that your body needs but cannot produce itself.

LOVAZA is used along with a low-fat and low-cholesterol diet to lower very high triglycerides (fats) in your blood. Before taking LOVAZA, talk to your healthcare provider about how you can lower high blood fats by:

- losing weight, if you are overweight
- increasing physical exercise
- lowering alcohol use
- treating diseases such as diabetes and low thyroid (hypothyroidism)
- adjusting the dose or changing other medicines that raise triglyceride levels such as certain blood pressure medicines and estrogens

Treatment with LOVAZA has not been shown to prevent heart attacks or strokes.

LOVAZA has not been studied in children under the age of 18 years.

Who should NOT take LOVAZA?

Do not take LOVAZA if you:

- **are allergic to LOVAZA or any of its ingredients.**

What should I tell my doctor before taking LOVAZA?

Tell your doctor about all of your medical conditions, including if you:

- drink more than 2 glasses of alcohol daily.
- have diabetes.
- have a thyroid problem called hypothyroidism.
- have a liver problem.
- have a pancreas problem.
- are allergic to fish and/or shellfish. LOVAZA may not be right for you.
- are pregnant, or planning to become pregnant. It is not known if LOVAZA can harm your unborn baby.
- are breastfeeding. It is not known if LOVAZA passes into your milk and if it can harm your baby.

Tell your doctor about all the medicines you take, including prescription and non-prescription medicine, vitamins, and herbal supplements. LOVAZA and certain other medicines can interact. Especially tell your doctor if you take medicines that affect clotting such as anticoagulants or blood thinners. Examples of these medicines include aspirin, nonsteroidal anti-inflammatory agents (NSAIDs), warfarin, coumarin, and clopidogrel (PLAVIX®).

How should I take LOVAZA?

- Take LOVAZA exactly as prescribed. Do not change your dose or stop LOVAZA without talking to your doctor.
- Your doctor should start you on a low-fat and low-cholesterol diet before giving you LOVAZA. Stay on this low-fat and low-cholesterol diet while taking LOVAZA.
- Your doctor should do blood tests to check your triglyceride and cholesterol levels during treatment with LOVAZA.
- If you have liver disease, your doctor should do blood tests to check your liver function during treatment with LOVAZA.

What are the possible side effects of LOVAZA?

The most common side effects with LOVAZA are burping, upset stomach and a change in your sense of taste.

LOVAZA may affect certain blood tests. It may change:

- one of the tests to check liver function (ALT)
- one of the tests to measure cholesterol levels (LDL-C)

Talk to your doctor if you have side effects that bother you or that will not go away.

These are not all the side effects with LOVAZA. For more information, ask your doctor or pharmacist.

What are the ingredients in LOVAZA?

Active Ingredient:

Omega-3-acid ethyl esters

Inactive Ingredients: Gelatin, glycerol, purified water, alpha-tocopherol (in soybean oil)

LOVAZA is a registered trademark of the GlaxoSmithKline group of companies.

PLAVIX is a registered trademark of Sanofi-Synthelabo.

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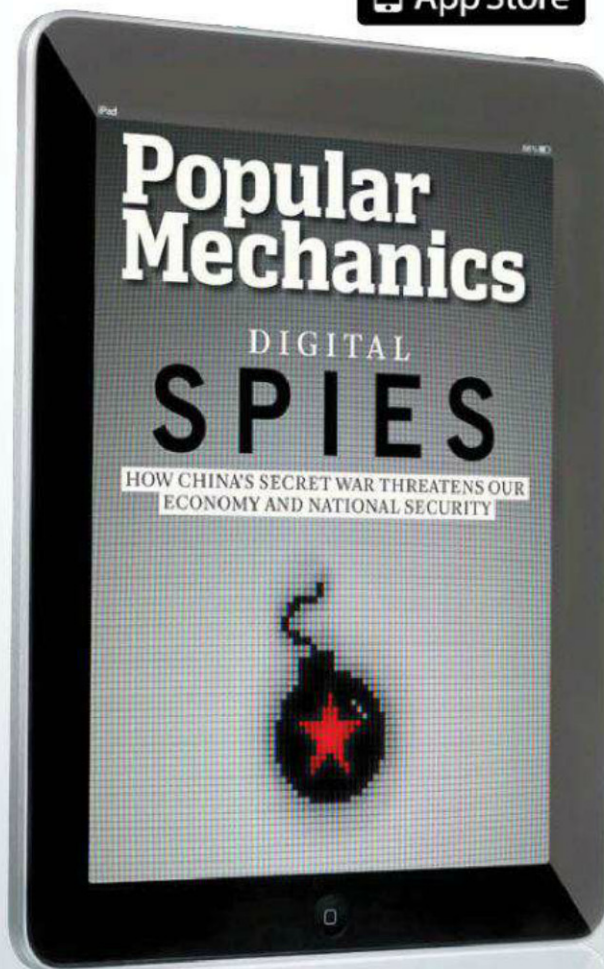
PROMOTION

SUBSCRIBE AND SAVE!

January PopMech iPad App

Each month, the Popular Mechanics team takes every word and picture of the print issue, optimizes it for the iPad and adds interactive functionality to enhance the individual stories. The result? PopMech: a must-have digital magazine! Download the app for free from Apple's App Store, then subscribe to access additional reporting, interactive diagrams, 3D models, videos, and links to online material, all with an easy-to-use interface.

Available on the
App Store



Critter Control

If gap-plugging copper wool isn't enough to keep bugs out, here's how entomologist Mark Sheperdigian (aka Shep), of Troy, Mich.'s Rose Pest Solutions, says to fight 'em off.



ROACHES: "Put traps in corners and in the backs of cabinets, liberally," Shep says. Use beer-soaked bread for big, solo water bugs. For German roach infestations, he advises calling a pro: "Those get out of hand."



RODENTS: Use classic snap traps for mice, Shep says. "Bait them with packing peanuts. Put the business end next to the wall." Give rats a week to learn to eat off the trap, then set it.



ANTS: Set liquid or gel baits in a trap near the ant trail. "Make one big pile," Shep says. Ants work together to take it all back to remote nests. Foragers are only a fraction of the population.

Take Back Trash With

Waste Management Strategies

Getting the upper hand on garbage is largely a logistical challenge. Any home piles and purges rubbish, but solutions for hiding it away and hauling it out make all the difference in how much the waste is seen (and smelled). A sound plan benefits the home's owners—and shuts out uninvited invaders. —H.S.



COMPOST HOLD

➔ Before heading to the heap, old eggshells and coffee grounds occupy the counter-top. Subdue the stink with Simplehuman's *Compost Pail* (\$60), an 11-inch-tall stainless-steel can with bamboo handles, which uses charcoal filters to absorb odors from its 1.2 gallons of festering contents.



THE KING BIN

Made of supple rotational-molded, medium-density polyethylene (not that brittle injected-HDPE junk), Toter's *96-gallon EVR II Cart* (\$90) is a major upgrade from a low-end rolling can. It carries up to 335 pounds of trash over a service life of 15 to 20 years.



SACK RACK

A big bag can hold a lot of bags, but sophisticated sack hoarders need Simplehuman's *Wall Mount Grocery Bag Holder* (\$10), a box that measures 15.6 x 6.3 inches, projects 3.6 inches from the wall, and stores up to 30 bags. End the plastic purgatory beneath the sink.



SMOOTH REFUSE

With a double-wall steel frame and full-extension runners capable of carrying up to 110 pounds, the silent, preassembled *Moovit* (\$249 for a double-bin) proves that Häfele is the Cadillac of sliding kitchen-cabinet hardware. Go for the Champagne palette.

ABUSIVE LAB TEST

Baby Boomboxes

Somewhere between headphones and home speakers lie Bluetooth-enabled wireless portable speakers, a class of products made for rocking and roaming. To find out how forcefully the little speakers bombard anyone within earshot, we tested three hot boxes. — HARRY SAWYERS



Sound Quality

We listened to *R.E.M.*, *Jurassic 5*, the Beatles, and *Thelonious Monk* to test a range of instruments and production styles.

BOSE: Below full volume, the box pumped out rich vocals, deep sound, and subtleties like rattling snares and high-hat-cymbal echoes. Bass distorted at high volumes, but four drivers kicked out notable decibels.

JBL: Clear vocals, but small sound overall. High and low notes blended in the middle. Bass, despite four drivers, barely existed.

JAWBONE: Full volume sounded fine at 2 feet away. From across the room, quality was the worst tested. Bass had a hiccup tone. Jazz was like a telephone call on hold.

Portability

Is it easy to take this show on the road?

BOSE: The Bose rocks steady, with a projected 8-hour battery life. But it's bulky at 5 x 2 x 9.5 inches and almost 3 pounds.

JBL: Four AA batteries last up to 5 hours in this 2-inch-tall, 6.5-inch-diameter disc.

JAWBONE: Weighing 12 ounces and measuring 1.5 x 2 x 6 inches, the Jambox is the most portable item. Its rechargeable battery is rated for 10 hours' sustained use.

Ease of Connection

These speakers sync with iPhones and other portable devices. But is it easy? As for range, a phone could control each speaker well past its audible listening distance.

BOSE: Not intuitive to connect. We had to, of all things, read the instructions. The key: Hold down the speaker's Bluetooth button.

JBL: Tricky to connect. An accidental button mashing made a phone call through the speaker.

JAWBONE: Aces the setup—a voice from the speaker tells you it's connected.

Collision Test

To simulate a tailgating/picnic disaster, we pelted each speaker with a leather football to knock it off a 30-inch-tall table.

BOSE: The SoundLink's removable case suffered an unsightly dent, but the speaker continued to function after a spill.

JBL: The On Tour iBT's shiny plastic case acquired a permanent scuff after catching a tight spiral, but its rubber feet held firm.

JAWBONE: The lightweight Jambox popped off the table after slight contact, but it took no noticeable damage.

BOTTOM LINE

To gain portability and battery life, these all compromise sound quality. Small drivers and speakers can push only so much air. (Bluetooth compression did not harm the sound, defying our expectation.) For a picnic or a party in a tent, the Bose model is the best of the bunch. But for \$300, audiophiles may prefer a rechargeable dock.

EARTHSHAKING

1

2

3

4

5

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7

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9

10

INSIGNIFICANT

IPHONE 4S
Same design, new guts and camera. The freshest thing about the 4S is Siri, the first smartphone voice-control system that isn't absolutely terrible. (\$200)

SAMSUNG GALAXY NEXUS Android 4.0, known to tech nerds as Ice Cream Sandwich, was announced alongside this enormous, 720p smartphone standard-setter. (\$TBA)

ASUS UX21
A superthin, brushed-metal laptop with respectable muscle, the Asus UX21 is the first affordable PC that might actually be prettier than a MacBook Air. (\$1000)

KINDLE FIRE
Whether Amazon's 7-inch Android tablet is a great product doesn't really matter. At less than half the price of the cheapest iPad, it doesn't need to be. (\$200)

NEST THERMOSTAT
A learning thermostat from one of the original designers of the iPod. It looks nice and it's easy to use, but, well, it's still just a thermostat. (\$249)

AMD FX PROCESSORS
The FX series of processors recalls the days when AMD, the Other Processor Company, could compete with Intel on performance—and win on price. (\$175)

LTE 4G There are only two real 4G wireless standards, WiMax and LTE. Sprint was the only cellphone carrier to support WiMax, but just dropped it like a hot potato. So, LTE it is.

JAWBONE UP
This app-controlled wristband tracks exercise, sleep, and calories—the whole biometric shebang. If you must wear a gaudy bracelet, it might as well make you healthy. (\$100)

ZUNE Microsoft's iPod alternative has finally been laid to rest, but it reeked of death from the beginning—by the time the touchscreen Zune HD came out, the iPod had already won. (\$RIP)

BEATS BY DR. DRE HEADPHONES
Now in two new colors! These reasonably attractive, decent-sounding, and absurdly overpriced headphones are a marketing triumph—the tech world's Air Jordans. (\$300)

The Tech-O-Meter

→ New gadgets hit the market at such a fast pace that they can become a blur. Here we present 10 items worth focusing on, for better or worse. *BY JOHN HERRMAN*

ROAD REVOLUTION.

YOU'RE NO LONGER ALONE.

SOCIAL NETWORKING FOR THE ROAD

Radar detection has traditionally been a solitary pursuit: one driver, one car, one unit. Now the revolutionary new ESCORT Live! lets you tap into an entire network of drivers for the most powerful real-time protection against laser-speed monitoring and other threats like speed traps and fixed-position cameras.

THE DRIVING FORCE: TEAMWORK

Accurate, affordable, and easy to use, this breakthrough technology enables lightning-fast communication between ESCORT Live! units. So when

you—and scores of other ESCORT Live! owners—hit the road, a nation of “scouts” is deployed to detect and instantly alert you about high-risk ticket situations.

ABUZZ ABOUT ESCORT LIVE!

ESCORT Live! has recently won the trifecta of top industry awards: **SEMA Best New Mobile Electronics Product**, **CES Innovations Award**, and **Popular Mechanics Editors Choice Award**. Now impassioned ESCORT Live! owners are hitting the social-media circuits, encouraging other drivers to join the ultimate road revolution.

POPULAR MECHANICS READERS TAKE ESCORT LIVE! FOR A SPIN

ESCORT DETECTORS COMPATIBLE WITH **ESCORT LIVE!**



REDLINE

PASSPORT 8500 X50



PASSPORT 9500ix



CONNECT VIA SMARTCORD LIVE



UPGRADING IS EASY

If you're already an ESCORT consumer, it's a snap to upgrade. Just use your current unit, and purchase the ESCORT Live! bundle, which includes:

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- ESCORT Live! app for smartphones*
- ESCORT Live! subscription

Then connect the SmartCord to your ESCORT radar detector, download the app—which includes live-traffic capability—and get instant access to the best ticket-protection network anywhere.

GET THE ULTIMATE TICKET PROTECTION

Don't own an ESCORT radar detector? No problem! You can get the ultimate ticket protection package by purchasing a new detector with ESCORT Live!

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SEMA Best New
Mobile Electronics
Product



Popular Mechanics
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PopMech



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Award

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for more information.



Jumpstart your own road revolution with the ESCORT Live! It's like a social network for the road—so you can know sooner, react faster, and drive smarter.

ESCORT Live!
User Report:
LIVE LASER AHEAD



Map View

Dashboard View

We invited a select group of *Popular Mechanics* readers to test the revolutionary new ESCORT Live! Our revved-up testers jumped at the chance — they would be the first consumers in the nation to try out the device before it hit the shelves. After a short debriefing on how the ESCORT Live! system works, we turned them loose on the road and waited for their reactions. Were they pleased? Read on.



J. Clark: "The system is like a human—it learns. So I won't have to worry about false alarms!"



J. Cohen: "The technology is really good. Once this launches and lots of people get on the network, it will be fantastic—especially when you take trips."



P. Smith: "Since I already have a smart phone, the system is very simple to use. It's very cool and will be a big help on the road!"



L. Molnar: "Having a really good detector like this is huge. But when you add a network feature that allows other people to warn you there's laser ahead, that means the world to me."



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KILLER M5 + SHOCKING CONCEPTS

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motors powered by a
22-kWh battery pack and
a 260-hp gas-engine
backup generator**TRANSMISSION**

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EV RANGE

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0-60 MPH

5.9 seconds



FRISKY FISKER

No 5000-pound luxury sedan with a 124-inch wheelbase and 22-inch wheels has a right to be this athletic, smooth, and collected, whether hustling or cruising. The Karma, Fisker's first car, is a plug-in hybrid. A pair of 201-hp electric motors drive the rear wheels, and when the 22-kilowatt-hour battery pack is depleted (after roughly 50 miles) or when the driver calls for full power with the Sport mode, a GM-supplied turbo four-cylinder fires to spin a generator. We love this car's dual personality, Bentley-beating interior, solar-panel-covered roof, and the sexiest silhouette this side of Scarlett Johansson. But oh, boy, that gas engine is a noisy beast when it's running. Fisker says a fix is in the works. We hope that's true, because the Karma could, like the Volt, change the way drivers perceive EVs.

— COLIN MATHEWS



New Cars TEST DRIVES

AUTO INTEL

1-5 *Stretching from Canada to Oregon, Interstate 5 in Washington will be the first "electric highway," with EV charging stations every 40 to 60 miles. Eventually, the West Coast Green Highway project will install chargers all the way south to Mexico.*

2 *The rough percentage, by weight, of the element lithium in a typical lithium-ion battery. Lithium salts are used in the electrolyte and transfer the electrical charge from the cathode to the anode.*

LOOKING UP!

VW's Up is the German company's latest gas-powered fuel sipper. It's just 140 inches long, half a foot shorter than the stubby Mini Cooper, and, like the Cooper, it seats four. A wide range of powertrains will be available: a 1.0-liter three-cylinder with either 59 or 74 hp, a natural-gas-burning version, and eventually an electric version. The gasoline motor is deceptively smooth despite its lack of balance shafts (internal rotating rods that quell engine vibration) and delivers well over 50 mpg. And while the 100-mph top speed and modest acceleration are hardly headline making, Up can hold its own in modern traffic. Currently, VW has no plans to sell the Up in the U.S., but if fuel prices spike, that could change. — ANDREW ENGLISH



ELECTRIC ANGELENO

A

Among the startups anticipating an emissions-free electric future is Los Angeles-based Coda, which is partnered with a Chinese battery firm. The two companies are building a five-passenger sedan with an EPA-rated 110-mile range and 134 hp, making it gutsier than Nissan's Leaf. A rush-hour spin through L.A. revealed a few kinks (the Coda is still in the preproduction stage), but when the \$44,900 newcomer debuts in December 2011, it will offer yet another reason to ditch fossil fuels and go electric. With its 1980-vintage Mitsubishi body, though, the Coda isn't likely to win any style awards. — BASEM WASEF

2012
VW Up!

2012
Coda Sedan



New Cars TEST DRIVES

O FIVE-PASSENGER SUPERCAR

BMW's line of M cars launched in 1978 with the racy M1, and the family tree is littered with some deliciously rough-edged street cars. But the 2013 M5 (\$90,000 estimated) might throw enthusiasts for a loop. Sure, its twin-turbocharged, 4.4-liter V-8 offers more power (560 hp, 500 lb-ft) and 30 percent better fuel economy than the last model, but this sedan's outrageous performance is married to a surprisingly drama-free driving experience. Thrust is so

locomotive-like that it makes the claimed 0-to-62-mph time of 4.4 seconds seem erroneously humble, yet the cabin is quiet enough for a conversation as you blaze down the highway. The seven-speed dual-clutch gearbox worked wonderfully during hot laps at southern Spain's Ascari racetrack, where the M5 exuded poise and superlative brake feel. It's hard to argue with the M5's capabilities, but we'd trade some of the polish for a bit more character. Often, the cars we love aren't perfect. —BASEM WASEF



2013
Chevy Malibu

2013
BMW M5

ZERO The total profits Tesla Motors, which makes EVs, has earned since its 2003 inception. Now that the \$110,000 Roadster is out of production, Tesla's hopes for profitability hinge on the Model S, which is due next year. Early prototypes look promising.

32 The estimated highway mpg of BMW's upcoming hybrid 5 Series. This new powertrain uses a twin-turbo straight six and an electric motor in front of an eight-speed automatic. Expect it later this year.

INTEL

AUTO

MIDSIZE BEAUTY



Chevy's current Malibu was General Motors' first midsize car that could stand next to the stalwart Toyota Camry and Honda Accord. Now Chevy aims to step ahead with a completely redesigned version. The exceedingly handsome 2013 model will arrive in showrooms in early 2012, and as is the current trend, it won't be available with a V-6. In addition to the base 2.5-liter inline four, an ECO model will use a mild hybrid powertrain to boost highway fuel economy to around 38 mpg, a heady figure for a roomy car that should cost around 26 grand. Plus, the Malibu's got moves. At GM's Milford, Mich., test track, where we drove a prototype, the sedan's suspension provided a resilient ride and well-controlled body motions. If there's one flaw, it's the engine's slightly raucous tone as it nears redline. But there's much to like, including up to 10 available airbags and a large center screen that moves upward to reveal an extra storage compartment. —GARY WITZENBURG



New Cars TEST DRIVES

SAFE BET

2012
Subaru Impreza2012
Mini Cooper Coupe

T

The 2012 Impreza has gone back to its econobox roots. While it still comes standard with all-wheel drive, it sports a smaller, less powerful 2.0-liter engine (148 hp and 145 lb-ft of torque) than last year's model and has a new give-me-a-minute-to-think-about-it exterior. Efficiency, however, is vastly improved. The car is 165 pounds lighter, and this, plus the new engine, boosts fuel economy a whopping 30 percent to 25/34 mpg with a five-speed manual and 27/36 with the CVT. That CVT works fine in normal use, but it's not a good complement to the car's sporty handling—the transmission feels slow to alter the ratios. The roomy interior has been upgraded with the addition of soft-touch materials, tilting headrests, and a separate info display above the center stack in all models, but the base model's center stack and dash feel and look dated. Still, when it comes to all-weather performance and versatility—especially for the five-door hatchback—the Impreza is a solid entry. — JAMES TATE

LITTLE DEUCE COOPER

Mini fears its cars are getting stuck in the "cute" category, so now we have a new model with a truncated rear hatch and no rear seats in an effort to make the brand seem sportier. The Coupe (\$22,000 base price) and its twin, the soft-top Roadster (due in February), still roll on the standard Cooper's chassis. Horsepower options are also identical to the Cooper's and range between 121 and 208 from the 1.6-liter four. More obvious external changes include a steeply raked windshield and a secondary spoiler that deploys at 50 mph off the lip of the hatch's abrupt tail. Ditching the back seats allowed engineers to stiffen the car's structure. As a result, the Coupe is more poised entering and exiting corners, and when the pavement turns to potholes, the car feels pinned to the ground. Still, this is a niche animal that lacks the pure machismo of, say, a Mustang, and offers even less of the Mini's limited practicality. — MICHAEL FRANK

AUTO

INTEL

1964

The first year a Mini Cooper won the Monte Carlo Rally, cementing the car's reputation as a tiny and unlikely speed demon. In late 2010, Mini reentered World Rally competition with a heavily modified version of the Countryman.

265

The horsepower of the fabulously entertaining WRX version of the Subaru Impreza. That model remains unchanged for 2012 and won't get the updates of the standard Impreza for another two years.

IS NATURE CALLING TOO OFTEN?



Jalyn®

(dutasteride and tamsulosin HCl)
Capsules
0.5 mg/0.4 mg

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For guys with symptomatic benign prostatic hyperplasia (BPH), nature calls a little too often. JALYN can help reduce urinary symptoms of BPH in men with an enlarged prostate. JALYN is not approved for the prevention of prostate cancer.

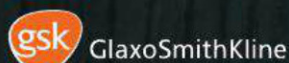
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www.JALYN.com

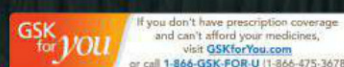
Important Safety Information About JALYN

- JALYN is for adult men only. Women should not take or touch JALYN due to risk of a specific birth defect. If a woman comes in contact with leaking JALYN Capsules, she should wash the contact area immediately with soap and water.
- Do not take JALYN if you are allergic to dutasteride, finasteride, tamsulosin, or any of the ingredients in JALYN.
- JALYN may cause rare and serious allergic reactions, including: swelling of your face, tongue, or throat, and serious skin reactions, such as skin peeling. Get medical help right away if you have these serious allergic reactions.
- JALYN may cause a sudden drop in blood pressure upon standing, especially when starting treatment, which may cause you to faint, or feel dizzy or lightheaded. Avoid driving or operating hazardous equipment when starting or restarting JALYN.
- Tell your doctor about all the medicines you take, including prescription and non-prescription medicines, vitamins, and herbal supplements. JALYN and other medicines may affect each other, causing side effects.
- Some types of medicines should not be taken with JALYN, including: ketoconazole, an antifungal medication, which if taken with JALYN can increase levels of tamsulosin, a component of JALYN; and alpha-blockers, like tamsulosin, which if taken with JALYN may cause fainting, dizziness, or feeling lightheaded.
- Some types of medicines should be used with caution when taken with JALYN, including: erythromycin, paroxetine, or terbinafine, which when taken with JALYN can increase levels of tamsulosin, a component of JALYN; cimetidine; certain types of medicines that are commonly used to treat erectile dysfunction, which when taken with JALYN may cause fainting, dizziness, or feeling lightheaded; and warfarin.
- Only your healthcare provider can tell if your symptoms are due to BPH or a more serious condition like prostate cancer. See your doctor for regular exams.
- JALYN may cause serious side effects including a higher chance of a more serious form of prostate cancer.
- Your healthcare provider may check you for other prostate problems, including prostate cancer, before you start and while you take JALYN. A blood test called PSA (prostate-specific antigen) is sometimes used to see if you might have prostate cancer. JALYN will reduce the amount of PSA measured in your blood. Your healthcare provider is aware of this effect and can still use PSA to see if you might have prostate cancer. Increases in your PSA levels while on treatment with JALYN (even if the PSA levels are in the normal range) should be evaluated by your healthcare provider.
- Rarely, JALYN can cause a painful erection. If this happens get medical help right away.
- Do not donate blood until 6 months after stopping JALYN.
- Before you take JALYN, tell your doctor if you: have a history of low blood pressure, plan to have cataract surgery, are allergic to sulfa medications, take medicines to treat high blood pressure, have liver problems, or have any other medical conditions.
- The most common side effects include: ejaculation problems, trouble getting or keeping an erection (impotence), a decrease in sex drive (libido), decreased amount of semen released during sex, dizziness, enlarged or painful breasts (if you notice breast lumps or nipple discharge, you should talk to your healthcare provider), and runny nose.

Please see the next page for Patient Information about JALYN.



You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.



PATIENT INFORMATION

JALYN™ [JAY-LIN] (dutasteride and tamsulosin hydrochloride) Capsules

JALYN is for use by men only.

Read this patient information before you start taking JALYN and each time you get a refill. There may be new information. This information does not take the place of talking with your healthcare provider about your medical condition or your treatment.

What is JALYN?

JALYN is a prescription medicine that contains 2 medicines: dutasteride and tamsulosin. JALYN is used to treat the symptoms of benign prostatic hyperplasia (BPH) in men with an enlarged prostate.

Who should not take JALYN?

Do Not Take JALYN if you are:

- pregnant or could become pregnant. JALYN may harm your unborn baby. Pregnant women should not touch JALYN Capsules. If a woman who is pregnant with a male baby gets enough JALYN in her body by swallowing or touching JALYN, the male baby may be born with sex organs that are not normal. If a pregnant woman or woman of childbearing potential comes in contact with leaking JALYN Capsules, the contact area should be washed immediately with soap and water.
- a child or teenager.
- allergic to dutasteride, tamsulosin, or any of the ingredients in JALYN. See the end of this page for a complete list of ingredients in JALYN.
- taking another medicine that contains an alpha-blocker.
- allergic to other 5 alpha-reductase inhibitors, for example, PROSCAR® (finasteride) Tablets.

What should I tell my healthcare provider before taking JALYN?

Before you take JALYN, tell your healthcare provider if you:

- have a history of low blood pressure
- take medicines to treat high blood pressure
- plan to have cataract surgery
- have liver problems
- are allergic to sulfa medications
- have any other medical conditions

Tell your healthcare provider about all the medicines you take, including prescription and non-prescription medicines, vitamins, and herbal supplements. JALYN and other medicines may affect each other, causing side effects. JALYN may affect the way other medicines work, and other medicines may affect how JALYN works.

Know the medicines you take. Keep a list of them to show your healthcare provider and pharmacist when you get a new medicine.

How should I take JALYN?

- Take JALYN exactly as your healthcare provider tells you to take it.
- Swallow JALYN Capsules whole. Do not crush, chew, or open JALYN Capsules because the contents of the capsule may irritate your lips, mouth, or throat.
- Take your JALYN 1 time each day, about 30 minutes after the same meal every day. For example, you may take JALYN 30 minutes after dinner every day.
- If you miss a dose, you can take it later that same day, 30 minutes after a meal. Do not take 2 JALYN Capsules in the same day. If you stop or forget to take JALYN for several days, talk with your healthcare provider before starting again.
- If you take too much JALYN, call your healthcare provider or go to the nearest hospital emergency room right away.

What should I avoid while taking JALYN?

- Avoid driving, operating machinery, or other dangerous activities when starting treatment with JALYN until you know how JALYN affects you. JALYN can cause a sudden drop in your blood pressure, especially at the start of treatment. A sudden drop in blood pressure may cause you to faint, feel dizzy or lightheaded.
- You should not donate blood while taking JALYN or for 6 months after you have stopped JALYN. This is important to prevent pregnant women from receiving JALYN through blood transfusions.

What are the possible side effects of JALYN?

JALYN may cause serious side effects, including:

- **Decreased blood pressure.** JALYN may cause a sudden drop in your blood pressure upon standing from a sitting or lying position, especially at the start of treatment. Symptoms of low blood pressure may include:
 - fainting
 - dizziness
 - feeling lightheaded
- **Rare and serious allergic reactions, including:**
 - swelling of your face, tongue, or throat
 - serious skin reactions, such as skin peelingGet medical help right away if you have these serious allergic reactions.
- **Higher chance of a more serious form of prostate cancer.**
- **Eye problems during cataract surgery.** During cataract surgery, a condition called intraoperative floppy iris syndrome (IFIS) can happen if you take or have taken JALYN in the past. If you need to have cataract surgery, tell your surgeon if you take or have taken JALYN.
- **A painful erection that will not go away.** Rarely, JALYN can cause a painful erection (priapism), which cannot be relieved by having sex. If this happens,

get medical help right away. If priapism is not treated, there could be lasting damage to your penis, including not being able to have an erection.

The most common side effects of JALYN include:

- ejaculation problems
- trouble getting or keeping an erection (impotence)
- a decrease in sex drive (libido)
- dizziness
- enlarged or painful breasts. If you notice breast lumps or nipple discharge, you should talk to your healthcare provider.
- runny nose

Dutasteride, an ingredient of JALYN, has been shown to reduce sperm count, semen volume, and sperm movement. However, the effect of JALYN on male fertility is not known.

Prostate-Specific Antigen (PSA) Test: Your healthcare provider may check you for other prostate problems, including prostate cancer, before you start and while you take JALYN. A blood test called PSA (prostate-specific antigen) is sometimes used to see if you might have prostate cancer. JALYN will reduce the amount of PSA measured in your blood. Your healthcare provider is aware of this effect and can still use PSA to see if you might have prostate cancer. Increases in your PSA levels while on treatment with JALYN (even if the PSA levels are in the normal range) should be evaluated by your healthcare provider.

Tell your healthcare provider if you have any side effect that bothers you or that does not go away.

These are not all the possible side effects with JALYN. For more information, ask your healthcare provider or pharmacist.

Call your doctor for medical advice about side effects. You may report side effects to the FDA at 1-800-FDA-1088.

How should I store JALYN?

- Store JALYN Capsules at room temperature (59° to 86°F or 15° to 30°C).
- JALYN Capsules may become deformed and/or discolored if kept at high temperatures.
- Do not use or touch JALYN if your capsules are deformed, discolored, or leaking.
- Safely throw away medicine that is no longer needed.

Keep JALYN and all medicines out of the reach of children.

Medicines are sometimes prescribed for purposes other than those listed in a patient page. Do not use JALYN for a condition for which it was not prescribed. Do not give JALYN to other people, even if they have the same symptoms that you have. It may harm them.

This patient information page summarizes the most important information about JALYN. If you would like more information, talk with your healthcare provider. You can ask your pharmacist or healthcare provider for information about JALYN that is written for health professionals.

For more information, go to www.JALYN.com or call 1-888-825-5249.

What are the ingredients in JALYN?

Active ingredients: dutasteride and tamsulosin hydrochloride

Inactive ingredients: black ink, butylated hydroxytoluene, carrageenan, FD&C yellow 6, ferric oxide (yellow), gelatin (from certified BSE-free bovine sources), glycerin, hypromellose, iron oxide red, methacrylic acid copolymer dispersion, microcrystalline cellulose, mono-di-glycerides of caprylic/capric acid, potassium chloride, talc, titanium dioxide, and triethyl citrate.

How does JALYN work?

JALYN contains 2 medications, dutasteride and tamsulosin. These 2 medications work in different ways to improve symptoms of BPH. Dutasteride shrinks the enlarged prostate and tamsulosin relaxes muscles in the prostate and neck of the bladder. These 2 medications, when used together, can improve symptoms of BPH better than either medication when used alone.

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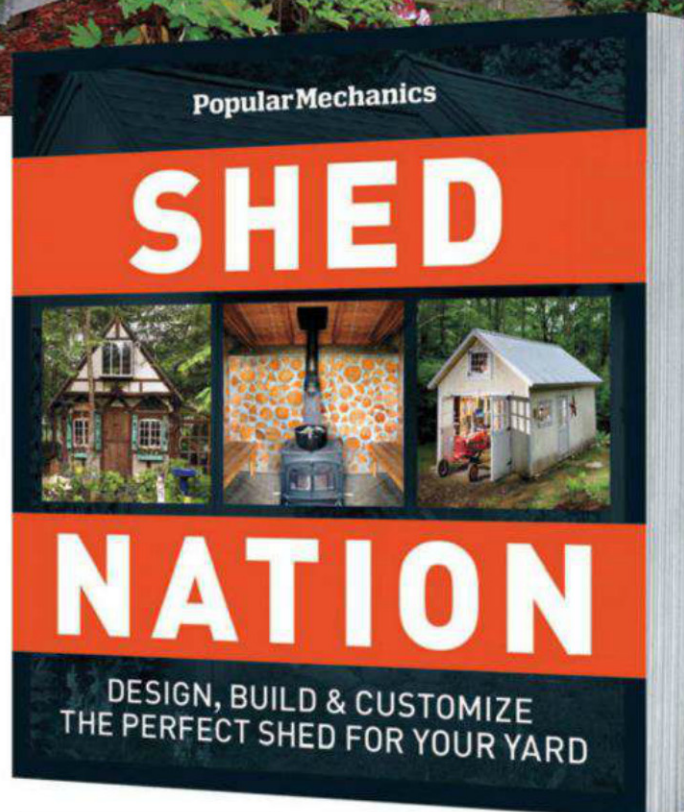
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New Cars TEST DRIVES

LIGHT AND LIVELY

Driving enthusiasts who get behind the wheel of the Euro-spec Mazda CX-5 will immediately want one. Thanks in part to the use of high-strength steel to lighten the chassis, it has exceptional handling. And the responsive 2.0-liter Skyactiv-G (gasoline) and 2.2-liter Skyactiv-D (diesel) powertrains emphasize Mazda's promise that performance is a core value for everything it makes—even compact SUVs. Europe gets a choice of gasoline or diesel, six-speed manual or automatic transmission, and front- or all-wheel drive. America will see the roughly 160-hp gas engine and the FWD/AWD choices, but availability of the crisp, Miata-like manual and the diesel are not definite, especially together. Yet that was the most fun version we drove, and it also rode on grippy summer-only tires, while the U.S. model will have all-weather rubber. The lightweight chassis and handling character should translate intact, and the gasoline engine itself is a technological triumph that could hit the 30-mpg mark in EPA combined ratings. We'll see what we get when the U.S.-spec model—slated for a February 2012 launch—is revealed. We say bring the diesel and let us shift for ourselves. The combination could set the CX-5 apart from the crowded small-SUV segment. But neither of those features has proven appeal to the American masses. — KEVIN WILSON



2013
Mazda CX-5

2012
Volvo S60 T6 R-Design AWD

INTEL

AUTO

2015 The year Toyota says we'll be able to walk into one of its showrooms and buy a hydrogen-fuel-cell-powered car. So far, manufacturers such as Mercedes, Honda, and GM have released fuel-cell cars only in low-volume test fleets.

1.8 The number of dollars, in billions, that the Chinese company Geely paid for Volvo in 2010. That figure was considerably less than the \$6.45 billion Ford spent to acquire the Swedish carmaker in 1999.

SAUCY SWEDE

Forget everything you know about the famously staid Volvo brand. Although packed with the expected long list of safety features, the S60 R-Design's turbocharged, 325-hp inline six motivates this BMW 3 Series fighter with zippy acceleration that squirts the 3835-pound sled to 60 mph in a scant 5.5 seconds. And the engineers stiffened the suspension by shortening the springs and installing thicker antiroll bars. The winding roads that cut through California's lush

Napa Valley were perfectly suited for this buttoned-down sports sedan, but hot laps at nearby Thunderhill Raceway left us wishing for paddle shifters to manually operate the gearbox and meatier brakes that are less prone to fade. In spite of those shortcomings, this \$42,500 S60 is a performance bargain equipped with an electronically managed all-wheel-drive system that will make mincemeat of all but the most formidable roads.

— BASEM WASEF



New Cars AUTO SHOW



FRANKFURT CAR SHOW

Every two years, the Frankfurt Motor Show kicks off the auto show season from the heart of Germany. This international venue draws dozens of new cars and outrageous concepts from around the globe. Here's an appetizer (more at popularmechanics.com/frankfurt). *BY LARRY WEBSTER*

FORD EVOS

Four gullwing doors, an idea we've never before seen, lent the proper outrageous tone to Ford's handsome showstopper. But, fantasy aside, the Evos previews Ford's upcoming design language. Expect to see style elements, especially from the nose, on the next Ford Fusion.



AUDI URBAN CONCEPT

VW and Audi displayed city runabouts that resembled the Automotive X Prize-winning Edison2. The 2's layout, which features a narrow cabin and exposed wheels, has some aerodynamic and weight advantages. Apparently the idea is catching on. Audi's concept uses a 20-hp electric motor, and there's also a droptop version.



JAGUAR C-X16

Now that the E-Type has turned 50—a car even Enzo Ferrari once admitted was "the most beautiful car ever made"—Jaguar may finally have a worthy successor. The C-X16 was the show's near-unanimous star. It's not slated for production, but this concept looked ready, and rumors swirled that Jaguar will eventually build it.



RIMAC CONCEPT ONE

A group of Croatians debuted the Rimac Concept One, an electric car that doubles as a lust object. Sleek bodywork wraps around a massive 92-kilowatt-hour lithium-ion battery pack and four independent electric motors that combine for a stunning 1088 total horsepower. If ever built, which is unlikely, it could sprint to 60 mph in 2.8 seconds.

HOLIDAY GIFT GUIDE

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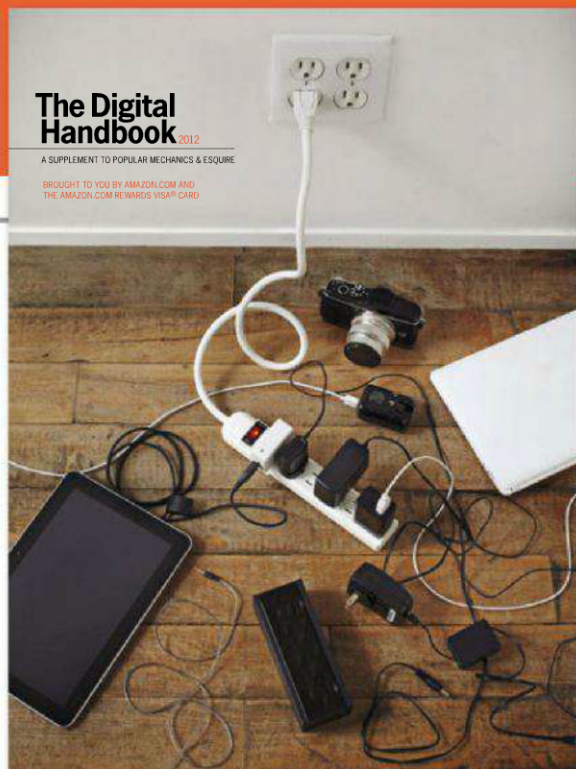
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SKYROCKETING TUITION AND DANGEROUSLY HIGH STUDENT DEBT CAN'T CONTINUE FOREVER. IT'S TIME FOR FRESH IDEAS.

continuing to rise. At public four-year schools, for instance, total costs rose 6 percent in 2011, to \$17,131—far outstripping inflation.

The causes are debated. Some blame palatial facilities and reduced teaching loads for professors, while one recent study fingered bloat in the ranks of administrators.

As tuition has risen, students and their families have made up the difference by borrowing. *The New York Times* ran a sad story about a woman who had amassed nearly \$100,000 in student loan debt pursuing a degree in women's and religious studies at New York University, only to find herself virtually unemployable upon graduation. Even students who major in programs shown to increase earnings, like engineering, face limits to how much debt they can sanely amass. With costs approaching \$60,000 a year for many private schools, and out-of-state costs at many state schools exceeding \$40,000 (and often closing in on \$30,000 for in-state students), some people are graduating with debts of \$100,000 or more. That's dangerous.

The rule of thumb is that college-debt payments should account for less than 8 percent of gross income. Otherwise, watch out—and remember that loan payments are usually not dischargeable in bankruptcy. The loans can follow you for decades.

Economist Herbert Stein famously wrote that if something can't go on forever, it won't. So college costs can't rise forever. The question is, what will happen next? It seems unlikely that college will return to its pre-World War II role as a finishing school for

The College Bubble

> BY GLENN HARLAN REYNOLDS
> ILLUSTRATION BY IAN KIM

A

S BUBBLES BURST IN ONE ECONOMIC SECTOR after another, we're now hearing talk of a "higher education bubble," in which cost increases, buoyed by cheap government loans, may be hitting their limit. Can technology save the day? Or does the problem go deeper than that?

No one disputes that college and graduate-school costs have skyrocketed. In recent decades, college tuition has increased at more than four times the rate of inflation, outpacing even medical-care costs and amounting to a 439 percent increase between 1982 and 2007. As *Forbes* recently noted, just a decade ago a year of college cost 18 percent of a typical family's annual income—now it has hit 25 percent and prices are

THINKING AHEAD/// COLLEGE BUBBLE

the wealthy. When education boosters tout college as essential to competitiveness in the global economy, they're mostly right (even though some workers can earn more and achieve higher job satisfaction in a skilled trade). The key to bringing college costs under control will be getting more bang for less buck. That's a challenge where technology might lend a hand, but only after some basic questions are addressed.

The first step is to ensure that students are actually learning useful things. This isn't much of a problem in engineering schools and the like, but in many other areas "core subjects" have been shortchanged. A recent survey of more than 700 schools by the American Council of Trustees and Alumni found that many have virtually no requirements. Perhaps that's why students are studying 50 percent less than they were a couple of decades ago.

Once this issue is addressed, there's plenty of room for improvement on the technological front. In the old days, professors were few, and it made sense for students to travel hundreds of miles to study with them. But today, once you move onto a campus, much of your learning, especially in the first couple of years, takes place in huge lecture halls where one professor addresses hundreds of students—or gets a teaching assistant to do it.

Some students are saving money by doing their first two years at community college. The quality of instruction is often better, and the classes smaller, than in four-year institutions where professors focus more on research than on teaching.

That's a worthwhile strategy, but innovation at four-year institutions could help

SKILLED TRADES LIKE ELECTRICAL WORK AND PLUMBING FACE A SHORTAGE OF QUALIFIED WORKERS, AND THESE FIELDS PAY WAGES THAT COMPARE FAVORABLY WITH THOSE EARNED BY COLLEGE GRADS.

too. Now that webcasts are a routine feature of corporate training, perhaps it's time to make better use of the Web for education. Take the top teachers in a field and let students at multiple colleges access their lectures online. (Sure, there's not a lot of interaction that way—but how much is there in a 200-student lecture class anyway?) Once the basic information is covered, students can apply it in smaller, advanced classes, in person. Would this save money? Possibly—and it would almost certainly produce better results.

The online approach is used by the popular Khan Academy, where lectures are viewed by students at their convenience and skills are perfected via video-game-like software, and the followup is done in a classroom, with a teacher's oversight. The idea is to

take advantage of mass delivery where it works best, and to allow individualized attention where it helps most.

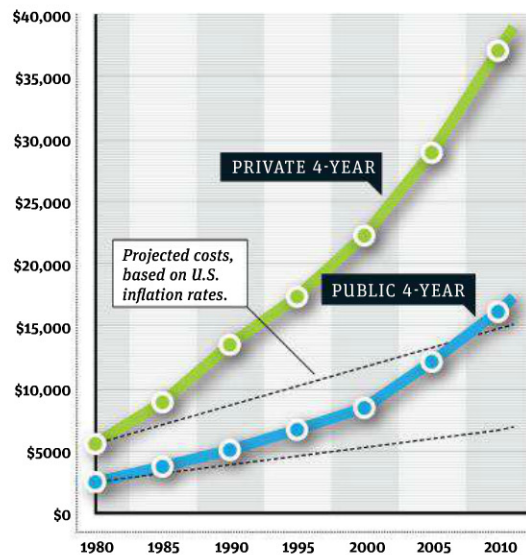
The Khan Academy has gotten a lot of attention, but it's not the last word in technological progress in education. What's striking is that it has come from outside the educational establishment. Then again, breakthroughs often come from people working outside the old industries. Anya Kamenetz's book *DIY U* talks about "edupunks" who are exploring unconventional thinking about teaching and learning. In fact, the best way to master many subjects may be for students to find their own path, with the role of the education establishment being more to certify competence than to actually teach. In one way, that's how it works already.

Right now, a college degree is an expensive signifier that its holder has a basic ability to show up on time (mostly), to follow instructions (reasonably well), and to deal with others in close quarters without committing serious felonies. In some fields, it may also indicate important background knowledge and skills, but most students will require further on-the-job training. An institution that could provide similar certification without requiring four (or more) years and a six-figure investment would have a huge advantage, especially if employers found that certification to be a more reliable indicator of competence than a college degree. Couple that with apprenticeship programs or internships and you might not need college for many careers.

The major problem with this plan is that college now

OUTSTRIPPING INFLATION

The average yearly cost (tuition, fees, room and board) for a private four-year institution is \$38,589. If hikes had matched inflation since 1980, the cost would be \$15,403. Public-school costs outstrip inflation as well.



SOURCES: COLLEGE BOARD, CONSUMER PRICE INDEX

serves largely as a status marker, a sign of membership in the educated "caste." However, the sight of college graduates buried in debt may change that. We're already seeing signs of a shift in popular culture, with advice-column pieces appearing that discuss women and men whose huge student debt makes them unmarriageable. At any rate, American culture at its best values people more for what they do than for their membership in a caste—now is a good time to assert that preference.

At the very least, students (and parents) should be looking more critically at what a specific course of study offers. Research by Georgetown University's Center on Education and the Workforce found that people who major in computer science, business, or engineering get a big lifetime-earnings boost, while people who major in the humanities don't do nearly as well. That's not a reason to look down on the humanities, but with college growing ever more expensive, a degree that won't add to your earnings potential isn't an investment, but an expensive consumer item. It may be nice to have—but so is a Ferrari, another expensive consumer item. The difference is, nobody's encouraging 18-year-olds to take on six-figure debt to buy a Ferrari.

There are many paths to increased earnings that don't involve college and that have smaller upfront costs: Skilled trades such as electrical work and plumbing face a constant shortage of qualified workers as Americans increasingly disdain manual labor, and these fields pay wages that compare very favorably with those earned by college graduates. There's an additional advantage to these hands-on jobs: They're harder to outsource. If you're a so-called knowledge worker in the global information economy, you're in competition with smart people all over the planet. If you fix cars or HVAC units, you're competing only with the folks in your neighborhood.


These attractions, *The Washington Post* reported last year, are leading a number of college-educated people to jump tracks and take up trades. Such people often cite the satisfac-

tion of hands-on work—and compared with many drone-like cubicle jobs, a trade career can be more intellectually stimulating. If you might be one of those people, why not skip the college and save the money? Community colleges and state vocational-technical colleges offer training in subjects such as plumbing, welding, and electrical work, and a licensed journeyman can make \$65,000 to \$85,000 a year.

Of course, that change would make life tougher on professors, such


as, er, me. But in the 21st-century economy, people or institutions who don't add value don't last long. The higher education establishment needs to ask itself if it's really adding value commensurate with the costs, and what it should be doing differently—before it's too late. **PM**

Full disclosure: Glenn Harlan Reynolds is a law professor at the University of Tennessee. He is also a blogger (instapundit.com) and author, most recently, of An Army of Davids.



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10 Tech Concepts for 2012

> BY JOHN HERRMAN

HAPPENING NOW

Pascalization



Louis Pasteur's name is synonymous with food preservation, but it's another long-dead French scientist, mathematician, and philosopher whose research is changing the way we think about food: Blaise Pascal. Pascalization, commonly known as high-pressure processing (HPP), is a method by which food is subjected to extreme water pressure—sometimes up to 80,000 pounds a square inch—inside long, cylindrical metal chambers. This destroys living cells, including harmful bacteria such as *E. coli* and listeria, while leaving the texture and flavor of many foods surprisingly intact.

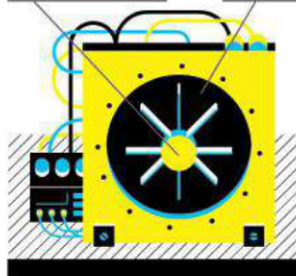
Sauces, fruit juices, guacamole, lunch meats, and fish hold up well to pascalization, and treated versions of these foods can be found in stores today. But falling equipment costs, demand for longer shelf lives, and a rash of bad PR for HPP's competition, food irradiation, will bring pascalization into the mainstream, says V. M. Balasubramaniam, a professor of food safety engineering at Ohio State University. "The food industry is conservative in terms of new tech," he says, "but in recent years the industry has grown into a multibillion-dollar business." Some extreme applications for pascalization include edible raw shellfish, and precooked eggs and omelets that can be stored at room temperature—for years.

A food processing unit at Ohio State University subjects a fresh bell pepper to over 600 megapascals (87,000 psi) of pressure.

TRENDING

DRIVESHAFT

EAPs



Plastic Muscles

Functional electroactive polymers (EAPs), known colloquially as plastic muscles, have been in development for decades, but their applications have been limited. (In 2005, the International Society for Optical Engineering held its first EAP versus human arm-wrestling match. Don't worry—the human won.) Recent research, however, has unlocked new potential for EAPs beyond sensors, actuators, and fanciful experiments. By placing large, flat spokes of EAP material between a floating hub and a fixed outer wheel, researchers at the Auckland Bioengineering Institute's Biomimetics Lab in New Zealand have been able to create a rotary motor, which could directly compete with the ubiquitous magnet-based electric motors in many low-power applications. The technology has drawn interest from NASA for its potentially high energy efficiency.

2012

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BIG IDEAS ///
10 TECH CONCEPTS

HAPPENING NOW

**Supertruck**

What does it mean for a long-haul truck to be “super”? According to new standards set by the Department of Energy, it means that it’s 50 percent more fuel efficient than today’s hardware—a goal the agency, with the help of Volvo, Daimler, Cummins, Peterbilt, and Navistar, hopes to hit by 2015. The new goals are specific to Class 8 trucks, which have loaded curb weights of 33,000 pounds or more; a full-to-capacity base-model Ford F-150 weighs about 6500 pounds.

More than \$180 million has been allocated by the DOE to engine and trailer manufacturers for a variety of projects, some reaching or nearing deployment. Near-term goals include wide-base low-rolling-resistance tires, active tire-pressure monitoring, hybrid drivetrains, and new trailer shapes.

Freightliner
Innovation Truck

Daimler Trucks is working on dramatically reducing the size and weight of its diesel engines, and Cummins is partnering with Peterbilt to produce a clean diesel engine with a waste-heat recovery

mechanism. What will make these supertrucks recognizable on the road, though, is their exterior: Aerodynamic trailers, cabins, and wheel skirts provide an almost sci-fi appeal.

BEHIND THE SCENES

SUBCONSCIOUS MODE

Anyone who has woken up to a dead phone can attest that mobile devices suck energy whether you’re using them or not. That’s because, even when a device is inactive—say, in your pocket with the screen off—it remains alert for wireless data transmissions, in a state known as idle listening. University of Michigan researchers have developed a technology called Energy-Minimizing Idle Listening, or subconscious mode, which dramatically lowers the rate at which a device’s Wi-Fi card retrieves data packets. By selectively listening only for small headers, or tags, the device is able to anticipate incoming data and open up its full wireless connection capabilities accordingly. In testing, subconscious mode reduced energy consumption by 44 percent in current mobile devices.

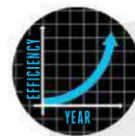


HAPPENING NOW

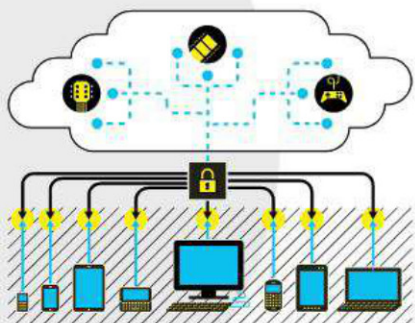
Mobile Instant Messaging

BlackBerry Messenger (BBM) paved the way for Internet-based mobile instant messaging. Apple, Google, and Microsoft now have MIM services of their own, sentencing overpriced texting plans to a well-deserved death.

TRENDING

Koomey’s Law

If one piece of computer science trivia can be said to have entered the collective consciousness, it’s Moore’s law. First formulated in 1965 by Intel co-founder Gordon Moore, it states that the number of transistors that can be placed on an integrated circuit will double every two years. In other words, processors become roughly twice as powerful every other year. Moore’s law is still holding strong, but it has little to say about energy efficiency. Koomey’s law is a proven computing law for the modern age, where wattage trumps all. Initially observed by Jonathan Koomey of Stanford University, Koomey’s law states that the amount of computing power per joule—effectively per watt—doubles every one and a half years. This trend tells us about the future of computing’s most exciting areas in a way that Moore’s law can’t, with equal relevance to battery-dependent smartphones and unfathomably powerful—and power-hungry—supercomputers.



Convergent Encryption

Server space, while cheaper than ever, still costs money. People have justifiable reservations about storing private data on a company's servers. But of all the hurdles faced by cloud computing services, bandwidth is the highest: It takes hours to upload one gigabyte over a typical broadband Internet connection. Bitcasa, a new startup, is offering full cloud backup—everything on a computer—for \$10 a month, using a technique called convergent encryption. Bitcasa's software assigns an anonymous hash, or identifier, to files before they're uploaded. If that hash already exists on Bitcasa's servers, it isn't re-uploaded; a popular song owned by millions would exist only once on Bitcasa's servers. This lets a Bitcasa user securely back up hundreds of gigabytes of data over an Internet connection that otherwise would have been prohibitively slow.

TRENDING

Flywheel Hybrids



To store kinetic energy in a battery, it must first be converted into electricity—a process that makes battery-powered hybrid cars inherently inefficient. Flywheel hybrids sidestep this problem in an elegantly simple way: Kinetic energy is stored as kinetic energy, in a spinning wheel.

In specialized applications, flywheel hybrids have been in use for decades. Switzerland deployed flywheel-assisted buses in the early '50s; an industry consortium called Flybus is currently testing a modern update on the concept. Porsche has even demonstrated the technology in a race-ready concept car, the 767-hp 918 RSR. In a much larger form, flywheel batteries serve as a grid-storage technology, holding excess energy during off-peak-usage hours.

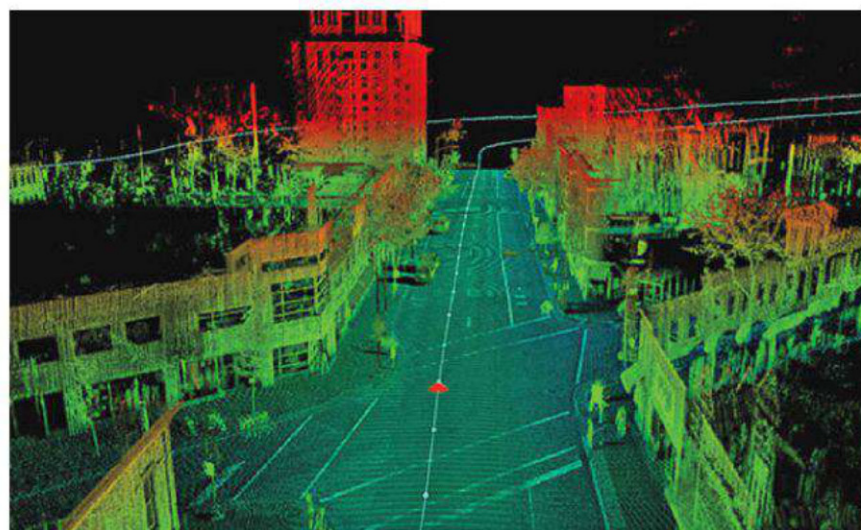
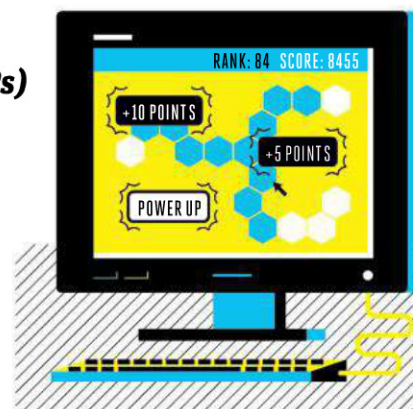
Until this year, flywheel storage in mainstream cars has been elusive. A team of car companies, including Ford, Jaguar, and Land Rover, has joined with motorsports companies Flybrid Systems and Prodrive to develop a carbon-composite flywheel battery, driven by a brake-powered continuously variable transmission and housed in a partial vacuum. In real-world testing, the consortium saw fuel-efficiency improvements of 22.4 percent over unassisted engines. At peak power, the flywheel returned 80 hp to the car's drivetrain.

Flywheel hybrids also promise to be easier on the environment after death. Chemical batteries require special disposal measures; flywheels don't.

HAPPENING NOW

Games With a Purpose (GWAPs)

GWAPs apply human intuition to computational problems. By "playing" a 3D protein simulation on their PCs, lay users decoded the structure of a retrovirus protein that had stumped scientists for years in just a few days.



BEHIND THE SCENES

MOBILE LIDAR



You probably haven't seen one of Google's self-driving cars cruising down the road—yet. Nonetheless, the search company's (mostly) driverless fleet has been quietly racking up hundreds of thousands of miles on public asphalt in California and Nevada. (There has been one crash, though Google insists that, at the time of impact, the car was under human control.) These autonomous vehicles depend on military-grade optical sensing technology called light detection and ranging, or lidar. The camera mounted atop Google's cars renders a 360-degree, three-dimensional view of the car's surroundings, which Google's navigational software interprets and reacts to in real time.

PM

Long-Term Test Cars

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VITAL STATISTICS

Base price:
\$35,650

As tested:
\$37,150

**Extra-cost
options:**
Power sunroof

Drivetrain:
3.5-liter V-6, 6A,
AWD

**Engine
performance:**
276 hp, 248 lb-ft
of torque

**EPA fuel
economy:**
18 city/
24 highway



2012 Sorento SX AWD

FIRST report

Like its parent company, Hyundai, Kia is making the right kind of noise with value-priced vehicles that don't feel cut-rate. Our loaded Sorento SX runs about 10 grand less than other SUVs with similar features, but there's slim evidence of cost cutting. With a 276-hp V-6, the Sorento accelerates briskly, and the handling is crisp for such a big guy. We have, however, noticed a few money-saving moves. The driver's seat, for example, is heated and cooled, but the

passenger gets only heat. The driver rules, right? Otherwise, the inside is quiet and roomy—except for the third row, which fits just kids. Still, for about 37 large, the Sorento comes with such luxuries as a heated steering wheel, a nav system and rear-seat HVAC. Plus, there's that stellar powertrain warranty: 10 years/100,000 miles. We'll see how this sometime off-roader survives a year of pothole-filled New York City. — LARRY WEBSTER

PM LONG-TERM TEST CARS



DRIVERS NOTEBOOK

- Cushy appointments turned highway time into comfy time—heated and cooled seats cater to the temperature-sensitive posterior,

and the rear-seat entertainment system hypnotizes the most unruly of children.

- The adaptive cruise control, which automatically slows with traffic, diffuses the monotony of endless asphalt.

DATA SO FAR

As tested:

\$45,480

Previous reports:

See 06/11, 09/11

Miles driven:

10,779

Miles since last report: 6414**Fuel economy:**

Average—17.9 mpg

Worst—14.2 mpg

Best—24.2 mpg

Maintenance/repair since last report: \$0**Overall:** \$31

2011 Jeep Grand Cherokee Overland

THIRD report

You hear it all the time—most off-road vehicles rarely encounter anything more challenging than a speed bump. But we took our Jeep Grand Cherokee on a trip up to a well-hidden lakeside lodge in New York state's Adirondack Mountains—6 hours of interstate followed by 8 miles of seriously muddy and unkempt logging trails. The Cherokee proved itself a formidable dirt hog, with features such as hill descent, a terrain dial (will you be dining on snow, sand, or rocks today, sir?), and an air suspension system that can boost clearance by up to 2.6 inches. These amenities gave the vehicle incredibly confident footing off-road (although the highest clearance setting makes for a tooth-jarring ride). That said, the Overland model is a spoiled rich relative to the \$27,490 4x2 Laredo, which we'd probably be shopping if it were our own money. At least they share the same marvelous 3.6-liter 290-hp V-6 engine, which was smooth and powerful, and ours still returned up to 24.2 mpg.

—GLENN DERENE



2011 Mazda2 Touring

Just how much car does one need? That was the question that constantly swirled during our 12 months with Mazda's diminutive hatchback. For commuting duties and in-town errand-running, the sprightly car distinguished itself as a four-wheeled energy drink. It sliced into cramped parking lots, zinged through congested highways, and regularly returned mid-30s mpg. Its simple interior layout felt less like we were making do with a cheap car and more like a welcome relief from overly complicated design. But when out on an open highway, the 2's four-speed automatic proved a gear or two short and kept the engine in a high-rpm buzz. Not only was that behavior irritating, it also hurt the fuel economy. In this car, the standard five-speed manual is the better option. Transmission aside, the 2 was surprisingly roomy inside and stable—even during a high-speed run across Nevada. We'd wager the inexpensive 2 is enough car for most drivers. —LARRY WEBSTER

FINAL report



DRIVERS NOTEBOOK

- After a 12-day, 5000-mile cross-country trip, the driver said, "I never cramped, and my usually sensitive back felt fine."
- Need another reason to skip the automatic? The five-speed manual ups the EPA fuel economy from 27/33 to 29/35.

END DATA

As tested: \$17,275**Previous reports:**

See 03/11, 06/11, 09/11

Miles driven:

16,416

Miles since last report: 6806**Fuel economy:**

Average—29.8 mpg

Worst—21.5 mpg

Best—39.7 mpg

Maintenance/repair since last report: \$81**Overall:** \$81



THE SECRET WAR

By Adam Piore



Foreign spies are hacking the computers of American industry and bleeding billions out of our economy. PM explores the dark, relentless scourge of digital espionage.

THE FIRST WARNING THAT HACKERS HAD PENETRATED the American oil company came soon after the initial breach, in the summer of 2009. The computer help desk received complaints from employees who were locked out of their accounts or whose computers had already been logged onto.

Then the complaints abruptly ceased: The digital spies had obtained an administrator password and were intercepting help-desk tickets, unlocking accounts, and notifying users that their problems had been fixed. With that access, the hackers copied thousands of confidential emails—including those of

Photograph by James Worrell Models by Megan Caponetto

top executives—and transmitted them to China in massive files late at night, after the oil company's employees had left for the day.

By the time the FBI informed the company of suspicious network traffic in the summer of 2010, Chinese firms had outbid the oil company on several high-stakes acquisitions by just a few thousand dollars. But it could have been far worse: For months, malware that allowed the hackers to take over terminals had been burrowing deeper into the company's systems and had wormed its way into computers that controlled oil-drilling and pipeline operations.

"People were alarmed that their email was compromised, but the hackers could have crippled the business," says Jonathan Pollet, the founder of Red Tiger Security in Houston. In early 2011, Pollet helped the oil company identify some of the hackers' breaches; he refused to name the company, citing a confidentiality agreement.

The example Pollet cites is just one incident in an ongoing, aggressive campaign of electronic espionage that costs U.S. firms billions of dollars, endangers our military secrets, and threatens to erode our technological edge, as computer hackers—often but not exclusively traced to China—help their clients, and their countries, gain the upper hand in business deals and steal intellectual property. (An October 2011 report prepared for the Director of National Intelligence titled "Foreign Spies Stealing U.S. Economic Secrets in Cyberspace" explicitly accuses China and Russia of hacking U.S. companies, calling Chinese hackers "the world's most active and persistent perpetrators of economic espionage.")

The phenomenon blurs the lines between white-collar crime, international spying, and even acts of war, but the attacks are known in the intelligence community as advanced persistent threats, or APTs. Well-financed, patient teams of hackers that U.S. intelligence agencies believe are backed by foreign governments now constitute a major national security risk. The hackers use tactics that are inherently difficult to trace and choose targets that have deep roots within U.S. infrastructure, government, and military. Recent news accounts have identified APT victims that include Google, ExxonMobil, Royal Dutch Shell, Morgan Stanley, Dow Chemical, Symantec, Northrop Grumman, and Lockheed Martin, to name just a few.

Private industry is understandably reluctant to reveal such breaches, even to the government: If a digital attack strikes fear in the hearts of a company's executives, one can only imagine how it would make shareholders feel. But digital spying is like a cockroach infestation—for every one that you see, thousands thrive out of view. "I can't find an organization, an entity, a business, or a department that hasn't suffered from cyber intrusions," says Gordon M. Snow, assistant director

of the FBI's Cyber Division. "If they really believe they haven't, they're just not aware of it yet."

In August 2011, a report by the security firm McAfee detailed hacks into some 72 public and private computer networks in 14 countries and warned of "the biggest transfer of wealth in terms of intellectual property in history."

Technology theft is the most common motive for digital espionage, but China and other nations have used it to squelch internal political dissent as well. Stolen source code from Google was used to hack into the accounts of Chinese dissidents, and after an Iranian hacker broke into Dutch security firm DigiNotar, the stolen technology was used to help his government spy on troublemakers in Iran. These attacks can cause collateral damage that compromises the security of everyone online. Digital security certificates from DigiNotar were part of the basic verification system of the Internet. If you can fake one of those, you can fool a browser into thinking any site is safe.

Hacked:
Heads of
State

A History of Hacks

THE UNITED STATES ITSELF IS NO slouch at cyber spying. The National Security Agency and the Pentagon possess the most sophisticated signals intelligence and digital warfare technology in the world. That gives us the ability to spy on foreign cellphone calls, shut down enemy air defenses, or even remotely cause equipment in an adversary's weapons facility to self-destruct.

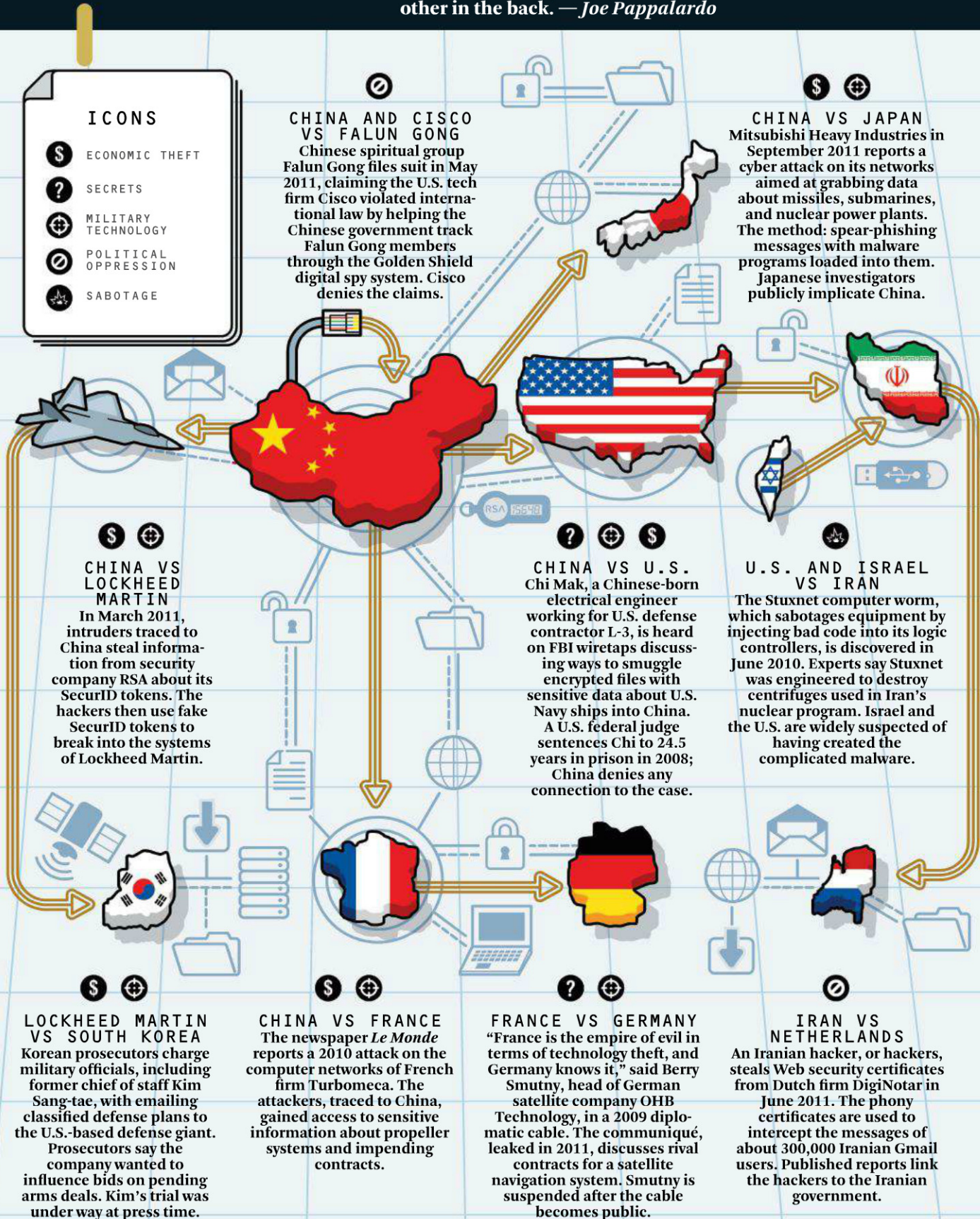
But former U.S. officials insist the government does not engage in economic espionage or intellectual property theft from foreign companies. In part, they contend,



German chancellor Angela Merkel (above) confronted China's premier, Wen Jiabao, during a 2007 state visit to Beijing after the magazine *Der Spiegel* reported that computers in the German chancellery had been infiltrated by Chinese malware. German officials traced the attack back to Trojan programs hidden inside Microsoft Word and PowerPoint files. The officials discovered the software trying to offload 160 gigabytes of data from government computers and send it to a botnet of hijacked computers in South Korea. The Germans believed the botnet was controlled by the People's Liberation Army.

WHO'S SPYING ON WHOM?

High-tech espionage is a game with no rules. In this secretive world, rival countries and multinational companies use invasive software, moles, and talented hackers to stab each other in the back. — Joe Pappalardo



that's because there is little IP we would want to steal, and to do so would undercut our efforts to discourage such theft by other nations. Private U.S. companies, meanwhile, would be breaking U.S. law if they hacked into the servers of state-owned competitors in places like China and Russia—although some U.S. multinationals have been accused of dirty business overseas (see “Who’s Spying on Whom?” page 55). “The U.S. has an enormous stake in the integrity of the intellectual property regime,” says Joel Brenner, former head of U.S. counterintelligence during the Bush and Obama administrations and the author of *America the Vulnerable*, a book on digital espionage published last September. “Many of our adversaries don’t believe we don’t do this. But it’s really true. We don’t.” According to James Lewis, a digital security expert at the Washington, D.C.-based Center for Strategic and International Studies, this apparent unwillingness to retaliate presents “an asymmetric disadvantage” that our rivals are exploiting to win an emerging digital cold war.

Computer espionage has a history almost as long as that of the modern Internet. In the late 1980s, the German hacker Markus Hess and several associates were recruited by the KGB to penetrate computers at American universities and military labs. They made off with sensitive semiconductor, satellite, space, and aircraft technologies. Today, China, Israel, and Russia are reportedly the most aggressive about stealing secrets. But China is playing a game of a different magnitude. “The Chinese didn’t create this problem,” Brenner says. “But there’s no question China is the worst offender now. They are all over us. It’s just relentless.”

Experts believe today’s attacks on U.S. industry are an extension of a series of attacks on American military computer networks that took place in the late ’90s and early 2000s. The assault has netted the Chinese sensitive military technologies that might one day be used against us. Then, as now, the Chinese government has vehemently denied that it has any state-sponsored hacking program, calling U.S. allegations groundless and irresponsible.

Plausible deniability is precisely what makes digital espionage such an effective tool. It’s difficult to detect and impossible to prove—and thus can’t be used to justify retaliation. Digital-security experts call this the attribution problem. “At most, you know the immediate computer involved in attacking you or receiving the stolen data—and sometimes you don’t even know that,” says Columbia University computer scientist Steven Bellovin, who advises the Department of Homeland Security on the issue. “But you don’t know who actually controls the computer. It could be another hacked computer someplace that somebody else is controlling from somewhere else.”

Still, few buy the Chinese denials. There have simply been too many attacks traced to the mainland. Last spring, secret State Department cables obtained by WikiLeaks and made public by Reuters detailed a widespread digital spying operation, Byzantine Hades, linked to the People’s Liberation Army Chengdu Military Region First Technical Reconnaissance Bureau, an electronic espionage unit of the Chinese military. According to the cables, Byzantine Hades targeted

not only the U.S. government and industry, but also high-level European officials. The Chinese hackers even managed to remotely activate the computer microphones and Web cameras of French officials so they could peek in on everything from office gossip to high-level diplomatic planning sessions. In the past, surveillance like that would have required spies to know where their targets were staying and mic the room—but in the age of cell phones and laptops, spies can listen in on foreign officials half a world away.

Anatomy of an Attack

IN FEBRUARY 2011, MCAFEE released a report detailing a series of hacks called Night Dragon. Emanating from locations in China and aimed at six global oil, gas, and petrochemical companies, the hacks resembled the oil company attack described by Pollet. The media later identified the victims as ExxonMobil, Royal Dutch Shell, BP, Marathon Oil, ConocoPhillips, and Baker Hughes, all of which declined to discuss the report when asked by POPULAR MECHANICS.

Regardless, the methods described by both Pollet and McAfee are straight out of the playbook of Chinese-based APTs. Instead of trying to identify vulnerabilities in a company’s firewall, APTs focus on exploiting the one thing that’s impossible to control—the vulnerabilities of company employees.

The hackers Pollet investigated found personal information about the oil company’s executives on social-networking sites such as Facebook and Myspace. Then they crafted emails aimed at enticing the executives to click on a poisoned link.

“The initial attack is very subtle,” Pollet says.

“It no longer says, ‘I am a Nigerian prince and need to hide a bank account.’ If the hacker can find an executive who likes to restore old cars and can find the names of some of his friends, he will send an email saying ‘Hey, I was talk-

DON'T GET HACKED

- Foreign spies aren’t after your PC, says Alex Stamos, CTO of security firm iSEC Partners, but the code from their hacks can be quickly mimicked by cyber criminals. “It’s like R&D for the broader malware market,” he says. Keep your software updated to stay safe.
- Any employee of a large company can become an attack vector for spies looking to steal data. “Be paranoid about what you click on,” Stamos says—even emails that seem to be from friends.
- Be careful if you store personal data on your work computer. If the machine becomes infected, your employer can erase everything.
- USB drives are classic tools for getting malware through a firewall. If you don’t trust where a drive came from, don’t plug it into your computer.

ast year, the Chinese military unveiled the Chengdu J-20 stealth fighter. Some U.S. intelligence experts see the J-20 as the result of a long campaign of technology theft. The Chinese are believed to have inspected and reverse-engineered aspects of an American F-117 Nighthawk downed in Serbia in 1999. Also, in the early 2000s, Chinese spies are suspected of hacking into a U.S. military research facility in China Lake, Calif., and making off with computer files relating to stealth technology.



ing to our friend Paul, and he said you were restoring 1950s Chevys. I found this great website you should check out.”

When the victim clicks on the link, it takes him to a webpage where malware loads onto his computer. It sits there for days until it wakes up and phones home.

The malware might post a code to a Twitter account or post a comment as simple as “I’m going skiing on Saturday” to a blog. That beacon alerts hackers that their malware has taken root and is ready for instructions. The hackers can then respond with coded directives by the same means.

It wasn’t until a year into the hack on the oil company that the FBI contacted executives and informed them they had spotted data traffic leaving their network and heading to servers in China known to be used to command and control networks, Pollet says. The FBI’s Snow says he cannot comment on specific cases. But it was certainly not the first time the FBI stepped in. The current campaign of cyber espionage is so widespread, he says, that it has forced a “significant cultural shift” in the way the FBI handles cyber intrusions. Previously, “the No. 1 priority was to protect the operational security of the investigation and the prosecutive equities on the criminal side.” While those goals are still important, “it’s even more important that the victims understand they have been victimized,” he says.

Emergency Response

AFTER THE FBI ALERT, THE OIL company brought in security firms Red Tiger and Mandiant to expunge the intruders. But expelling an APT isn’t as simple as it sounds. “They are agile, dynamic, and, if you defeat them once, they’re going to change their tactic,” says

Richard Bejtlich, chief security officer for Mandiant, who also would not comment on the specifics of the oil company attack. The attackers, he notes, are usually in it for the long haul and are likely to return if the company still has intelligence on its networks that the hackers or their employers consider of value.

The best approach once an intrusion is detected is not to tip your hand until you are ready to respond with a serious defense. Countermeasures usually involve

first identifying as many infected computers as possible by looking for suspicious software on hard drives and tracking which computers have been contacting suspicious host servers. The response team then attempts to pull as many infected computers as possible off the server at once, “by any means necessary,” Bejtlich says. “In some cases it’s literally pulling a cable out of the computer.”

But often it’s impossible to know whether all the malware has been successfully removed. And even if it has, the attacker will often attempt to break in once again, using more sophisticated, perhaps never-before-seen code. That’s one of the reasons that many in the intelligence community are calling for a new security paradigm, one that places an emphasis on information sharing and preventive measures.

The government can go only so far to protect the networks of private companies. In the past year, the Department of Defense launched a pilot program with the defense industrial base that helps contractors improve security and share information about emerging forms of malware. Most U.S. companies, however, remain shockingly vulnerable to massive security breaches and naive about the extent of the problem.

Even with cooperation, most security experts believe that keeping a capable and determined adversary out of a system is impossible.

“Perimeter defense is finished,” Brenner says. “If you want to talk about really confidential stuff in email, you’ve got to understand that if you’ve got a real sophisticated adversary, they’re reading it.”

The FBI’s Snow agrees. “We have to have a cultural shift in the nation where we understand that there is no secure system, that people are going to be hacked,” he says.

As for retaliation? Bejtlich says he often gets questions from high-level executives who want to “hack back,” even if all that means is retaliating against a Chinese computer with a virus that will disable it.

“There is sufficient resistance from outside counsel because it would violate U.S. law, and in U.S. government agencies, there is no support to do that,” Bejtlich says.

When asked if compromised companies might use the knowledge that they have been infiltrated to feed spies false data, Bejtlich scoffed. “Those deception maneuvers are so far beyond the capability of any private corporation that no one could pull that off,” he says. “You couldn’t protect the planning. The bad guys will see it all and laugh.” **PM**

Stolen
Stealth
Tech



Strangers in a strange land

by David Kushner

+

10 MOST ACCURATE

SCI-FI MOVIES

In late 2009, a writer, a producer, a director, and three scientists sat in a Los Angeles conference room. They were discussing Marvel's *Thor*—a film based on a comic book that was in turn inspired by the Norse god of thunder—about an arrogant warrior who, at the start of the film, violates a truce by attacking the Frost Giants. As the film team described their vision of the fight, Sean Carroll, a theoretical physicist at the California Institute of

Sometimes Hollywood gets the science right—or at least not completely wrong. With input from experts, we've picked sci-fi's most plausible big-budget films.

— Erik Sofge

2001: A SPACE ODYSSEY (1968)

Early in the film, a character takes a routine commercial flight to a space station aboard a shuttle sporting Pan Am's logo. Swap SpaceX for Pan Am, and *2001* predicts the ambition of the private spaceflight industry. Even HAL 9000's nuanced descent into lethal system error rings true. **Expert opinion:** "You can't train AI [artificial intelligence] for every problem it might have to solve," says roboticist and author Daniel H. Wilson, referring to HAL's response to learning that secrets are being kept from it. "Different levels of



Sean Carroll (left) is a physics research associate at CalTech—and acts as a consultant on sci-fi flicks. As filmmakers try to make their movies more believable, Carroll is just one of many scientists dispensing advice. But is Hollywood willing to listen?

photograph
by Robert Trachtenberg

Technology, knew the filmmakers had a problem. “They wanted the Frost Giants to fall off the edge of a disc-shaped planet,” he says. “That makes no sense. Where does the gravity to pull them down come from? Enough people know how gravity works that it would throw them out of the movie. You’d get a lot of giggles.” Carroll and the other scientists argued their point, even though, Carroll says, “it was clear some people thought we were being uptight killjoys.”

But producer Kevin Feige sided with the scientists, and in the final cut, the Frost Giants’ planet was spherical. That was just one way that Carroll, a clean-cut 45-year-old who has advised on films such as *TRON: Legacy* and the TV show *Bones*, helped the production. As punishment for breaking the truce, Thor is exiled to earth. When Feige complained that using the term wormhole for Thor’s passageway to our planet was “too ’90s,” Carroll suggested the scientific name for the phenomenon, the Einstein-Rosen bridge. That explanation is given by Natalie Portman’s character, astrophysicist Jane Foster, whose motivations Carroll helped shape.

Scientists have been helping Hollywood since the start of cinema. But as science-fiction movies account for more revenue—in the ’90s, an average of six a

year were in the top 50 moneymakers; that number increased by nearly 50 percent in the first decade of the 2000s—filmmakers are turning more frequently to experts for ideas. “The more you ground your film in the real thing, the better it plays,” says D.J. Gugenheim, VP of production at Inferno Entertainment. Scientists are willing to help Hollywood because they see a chance to expose a broader audience to science and humanize their profession. “People get images of what science is from movies,” Carroll says. “I want to help get that image right.”

To improve the information flow between the science community and Hollywood, the National Academy of Sciences launched the Los Angeles-based Science & Entertainment Exchange in 2008. The organization connects filmmakers with scientists in biology, chemistry, and other fields. In its first year the Exchange’s scientists consulted (for free) on 70 projects; by September 2011, on 350. Creators of TV shows such as *Fringe* and *The Big Bang Theory*, and films like *Green Lantern* and 2012’s *Battleship*, have all talked to scientists with the Exchange.

But science and entertainment don’t always mix. “Story creators might think scientists are geeks, but there’s a sense of respect,” says Malcolm MacIver, associate professor of biomedical engineering at Northwestern University and adviser on *TRON: Legacy*. “That respect is not always there in the other direction. Scientists feel that filmmakers dumb down everything to make a buck.” Despite holding scientists in high esteem, some filmmakers find them hard to work with. “Scientists say, ‘No, you can’t do that!’” Carroll says. “And the moviemaker finds that unhelpful.”

THESE DAYS, AUDIENCES ARE SAVVIER than ever. And thanks to the Internet, there’s little they haven’t seen—so filmmakers look to what’s happening in cutting-edge research. “Scientists are more imaginative than we are in Hollywood,” says Jeffrey Silver, producer of *Terminator Salvation* and *300*. “I used to say, that only happens in the movies, but now I say, that only happens in science.”

The average moviegoer is also less willing to suspend disbelief. “If people see a movie and sense a disconnect between the logic of the movie and the science that governs the world of the film,” Gugenheim

BLADE RUNNER (1982)

The heart of this neo-noir film—lab-grown replicants on the lam in Los Angeles—is no more or less plausible a premise today. But the backdrop against which they run, fight, and die is a warning of urban and environmental blight. The skies over L.A. are blotted and pouring rain, the implied result of carbon excess and climate change. **Real-life tech equivalent:** The flying cars are sci-fi's most realistic airworthy automobiles. These “spinners” are vertical-takeoff and -landing craft—similar to UrbanAero’s AirMule drone prototype (above)—that require headsets, contact with air traffic control, and a pilot’s license to operate.



MOST ACCURATE

CONTINUED



says, “you risk turning off the audience.” Viewers take their complaints to the Internet, where they spread faster than a zombie virus. “Advisers help you construct the movie with rules that keep you in the realm of what is theoretically plausible,” Gugenheim says. That’s what makes films feel real—and prevents bad word-of-mouth that could cripple box office.

SCIENTISTS ARE MORE CONCERNED that inaccuracies will harm scientific literacy. In *The Day After Tomorrow*, a man-made ice age occurred in just a week. It would actually take at least a decade for the real thing to set in. And when scientists in *K-19: The Widowmaker* worried that a nuclear reactor would explode, it spread a dangerous notion: Damaged reactors don’t explode, they melt.



ALIEN, 1979



GATTACA, 1997

classified information are exactly the wrench that could turn a predictable learner into a murderer.”

THE ANDROMEDA STRAIN (1971)



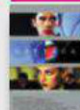
In this adaptation of Michael Crichton’s novel, the Pentagon uses a satellite to capture an extraterrestrial virus in order to study its potential as a biological weapon. Instead, the virus runs amok, mutating rapidly and killing almost everyone it encounters. The plot is not as far-fetched as it sounds. In the November 1962 issue of *POPULAR MECHANICS*, microbiologist Joshua Lederberg warned that “the return of such samples to earth exposes us to a hazard of contamination by foreign organisms . . . [including] the introduction of a new disease which would imperil human life.”

ALIEN (1979)



The utopian layouts and handy faster-than-light engines of most sci-fi spacecraft are nowhere to be found in *Alien*’s spaceship. The *Nostramo* is a snarl of leaking hydraulic lines, cramped eating quarters, and, for long hauls, hibernation pods. **Expert opinion:** Astronaut Tom Jones says the blue-collar craft “showed a future where space has become part of the industrial fabric. It will be a commonplace working environment, sometimes boring, sometimes dangerous, like an offshore oil rig—not an exotic lab.”

GATTACA (1997)



In its opening sequence, *Gattaca* presents its society-warping concept: that rapid, ubiquitous genetic sequencing will reshape the world. Whole lives will be mapped out from birth, and a new classism will emerge, based on genetic predispositions. Real life hasn’t caught up to the film’s neo-fascism, but the capability is coming: The \$10 million Genomics X Prize competition hopes to yield the first system that

Most scientists are willing to advise not only because it allows them to be gatekeepers of their disciplines, but because they want to be portrayed accurately on-screen. "It's rare that you have a relatable character," says Sheril Kirshenbaum, a research associate at the Center for International Energy and Environmental Policy at the University of Texas at Austin. That's why James Cameron created *Avatar*'s xenobotanist, Grace. "Scientists are usually shown as geeks or losers or evil," he says. "I wanted to celebrate the mind and the passion of a scientist."

WORKING IN HOLLYWOOD CAN BE AN educational experience for novice advisers, as Carroll discovered during his first consulting gig, on Ron Howard's *Angels & Demons*. In the film, Professor Robert Langdon tries to find antimatter stolen from CERN's Large Hadron Collider. It's a fact that when antimatter and matter come into contact, they annihilate each other in a violent explosion. What, Howard wondered, would it look like if that explosion occurred in the sky? Carroll suggested a series of rapid booms caused by air rushing into the vacuum created by the explosion.

But then the 2007 Writers Guild strike derailed both the production and his consultations. "They were over budget and behind schedule, and we didn't talk anymore," Carroll says. "That's Hollywood. I

DEEP IMPACT (1998)

Though NASA has updated its thinking on foreign-object deflection—a 2007 research paper proposed **flying a craft alongside planet-killers, tugging them off-course with gravity**—the movie was true to the technology of detection and interception at the time. **Expert opinion:** "It's almost a lesson," Jones says. "To find a movie that was accurate to asteroid physics was a nice surprise."

MOST ACCURATE

CONTINUED

can sequence entire genomes for \$1000 or less.

THE TERMINATOR (1984)



This pulpy vision of AI's most unsettling endgame—that robots could rebel against humanity, a concept still called the terminator scenario in academic circles—was surprisingly restrained. The Skynet defense network isn't malicious and power-hungry, just a complex program that has run off the rails.

JURASSIC PARK (1993)



The premise of this Crichton adaptation—wherein dinosaurs are cloned using blood extracted from preserved mosquitoes—was faithful to early '90s speculative genetics theories. But what

captured imaginations were the creatures themselves, which exhibited behaviors that were news to mainstream audiences. These weren't lumbering reptiles; the *T. rex* hit near-highway speeds, with the menace of a massive avian.

CONTACT (1997)



Much of *Contact*'s authenticity goes back to astrophysicist Carl Sagan, who wrote the original novel. He understood how radio telescope arrays work and why scientists would use math to translate an alien language. **Expert opinion:** Even the climax—Jodie Foster's wormhole ride to a distant planet—showcases enough quantum theory, Jones says, to be surprisingly credible, "with what's known about physics, and what might be possible one day."

MINORITY REPORT (2002)



The premise—psychics who predict crimes—is ridiculous. The film's gadgets are not: Self-driving cars are increasingly plausible, and the iris-scanning, targeted advertising will be in stores soon. **Real-life tech equivalent:** the holographic operating system. Researchers specializing in human-computer interaction still show clips of Tom Cruise swiping at midair applications to illustrate their goals. Microsoft's HoloDesk comes close—the research demo maps hand movements to projected images, letting users grasp virtual objects.

10 least accurate sci-fi films

These blockbusters distort research breakthroughs and transform fact-based warnings into fairy tales. —E.S.



THE BLACK HOLE (1979) When the protagonists' escape pod flies into one of the universe's most destructive phenomena, it isn't ripped apart, atom by shrieking atom. Instead, passengers have psychedelic visions and emerge safe and sound.



ARMAGEDDON (1998) NASA sends wildcatters to land on an earth-killing asteroid and blow it in half with a nuke—never mind that even a rock the size of Texas doesn't have the gravity to keep the rovers on its surface. **Ridiculous detail:** The rovers are equipped with mounted machine guns, which one character uses to open fire on everything in sight.



THE MATRIX (1999) Neo wakes to find that the machines are using humans' body heat for power—but in reality, burning the calories pumped into people would yield more energy.



VANILLA SKY (2001) The protagonist has been in a 150-year cryonic slumber while his neurons navigate a virtual world. But he went under in 2001, when real-life cryonics involved being decapitated and dunked in a vat of liquid nitrogen.



THE CORE (2003) A team drills to the center of the earth in a vessel made of unobtainium to restart the core. **Ridiculous detail:** The vessel is punctured by a diamond and gets dangerously hot. In reality, it would instantly fill with magma, unobtainium be damned.



THE DAY AFTER TOMORROW (2004) The plausible theory that changing temperatures could disrupt ocean currents, triggering an ice age, is rendered absurd when physics-defying waves of cold air descend from the stratosphere to freeze people solid.



I AM LEGEND (2007) A plague transforms humans into vampires; an immune virologist uses his blood to make a vaccine. But in real life, he'd have to be infected to create the antibodies for a cure.



INDIANA JONES AND THE KINGDOM OF THE CRYSTAL SKULL (2008) Stuck in the blast radius of a nuclear test, Indy hides in a lead-lined fridge. He survives, and decades of high-energy physics research—which show that the lead would melt—are vaporized.



2012 (2009) The sun barrages earth with mutated neutrinos, which superheat the core and set off a seismic apocalypse. **Ridiculous detail:** Glacial melting triggers a global flood. But there isn't enough water on earth to fuel such a biblical disaster.



ANGELS & DEMONS (2009) A gram of stolen antimatter is smuggled into Vatican City. The idea that highly unstable antimatter could be transported with ease is pure scientific blasphemy.

was pleasantly surprised by the intellectual curiosity of those involved, but disillusioned that you can't always do it right." *Angels & Demons* eventually hit theaters in 2009. (Carroll's contribution, he says, looked "more or less" as he advised.)

Often filmmakers ignore a scientist's advice. When paleontologist Robert T. Bakker worked on *Jurassic Park*, he found the dinosaur artists to be "better animal morphologists than most tenured professors." But when he sent the film team diagrams of the *T. rex*'s banana-shaped crowns, "the powers that be didn't like the real tooth shape," he says. "The CGI *rex* and the robot had their fangs sharpened."

Filmmakers defend their creative license; their first responsibility, they say, is to entertain. For 2012, director Roland Emmerich wanted an impossible global flood. "There isn't enough water on earth for that," he admits, "so you have to figure out something." Emmerich asked a geologist to work from the 1950s theory of earth-crust displacement. "He said, 'This could never happen.' And we said, 'Well, if it did happen, how would it work?'" Silver often talks to advisers, but even he says that "if [a story] doesn't break a fundamental law of physics, then it doesn't matter how far you stretch it."

Ultimately, advisers understand they're not creating award-winning research. "You have to accept that the goal is to tell a story first," says Kevin Hand, a planetary scientist at NASA's Jet Propulsion Laboratory. Science & Entertainment Exchange director Marty Perreault agrees: "We're not the science police." They also realize that these films could get young viewers interested in science. "I can write a book where I explain real physics and reach several thousand people," Carroll says, "or I can help create Natalie Portman's character in a movie that will reach 10 million people. And some will be young girls who see that Natalie Portman's playing a scientist."

Now that Carroll's done with *Thor*, he's moved on to *Doctor Strange*, about a surgeon who becomes earth's Sorcerer Supreme. Carroll's job is to apply limits to Strange's powers. "You need constraints to provide tension," he says. A world where anything can happen makes for a very boring movie. It's when science imposes boundaries on what a superhero can do that the real drama begins. **PM**

THE OUT SIDERS



BY BEN STEWART

PHOTOGRAPH BY DWIGHT ESCHLIMAN

OUTSIDE THE BOUNDS OF TRADITIONAL AUTO SEGMENTS LIE SPIRITED MACHINES THAT SIP FUEL, HAUL GEAR, AND DON'T LOOK LIKE RENTAL CARS. **WE PUSHED FIVE OF THESE FUNKY RIDES TO THEIR LIMITS ON BOTH ROAD AND TRACK.**

PM COMPARISON



↑
NISSAN JUKE



↑
SCION TC



↑
MINI COOPER



WHY DRIVE DULL?

Automakers are realizing that even though millions buy mainstream cars like the Toyota Corolla and Chevy Malibu, there's a burgeoning market for spicier alternatives. But unlike the well-defined segments such as midsize sedans where all the players are closely matched in size, basic shape, and even engine power, the "not sedans" follow a much looser formula. And so we have a growing group of cars that defy categorization. The Nissan Juke resembles a mini SUV, while the new Hyundai Veloster has a coupe-like profile but three doors. We matched those two with three



On Weenie Wednesday at Larry's Dawg House in Athens, Ohio, 1800 hot dogs will meet their end. Our five left-of-center cars line up at the drive-thru.

VW BEETLE

HYUNDAI VELOSTER

other cars from outside the mainstream—the Mini Cooper, the Scion tC, and the newly restyled VW Beetle. The only links among the five are a base price around 20 grand, quirky styling, over 30 highway mpg, and the promise that when the road curves, they won't simply be ready, they'll be willing. We took these cars on a three-day romp from Detroit to the curvy back roads of southeast Ohio, and we think they may represent an automotive sweet spot. These rides are economical yet spunky—eliciting grins as if they were high-dollar sports cars. Since they're all so varied, we didn't rank them from best to worst. Instead, we've included the usual test measurements and subjective opinions, then highlighted the strengths of these five funsters.

TO ILLUSTRATE EACH CAR'S STRENGTHS, WE'VE INCLUDED THIS 10-POINT SCALE AND HIGHLIGHTED THE ICONS TO DEPICT THE CAR'S BEST CHARACTERISTICS.



HANDLING

CARGO
HAULINGFUEL
ECONOMY

ACCELERATION



COMFORT



TRANSMISSION

EXTERIOR
STYLINGREAR
SEATINTERIOR
CRAFTSMANSHIP

VALUE



NISSAN JUKE

An outlier among oddballs. It's the only one available with all-wheel drive.

IN THIS BUNCH of irreverent cars, the Juke is like Lady Gaga—a little crazier-looking than anything else, but packing serious talent too. Based on the tiny Nissan Cube platform, the Juke feels tauter than most crossovers and handles nimbly, like it was built expressly for tight urban confines. It's fun to hustle, mostly because of the incredibly linear and potent turbocharged engine mated to the slick six-speed manual transmission. It sprinted to 60 mph in just 7.8 seconds. The Juke's tall center of gravity, however, and relatively soft suspension meant that when the road

turned curvy, it couldn't keep up with the sportier cars. Still, the Juke absorbed road jostles and jolts better than anything else. Inside, the proximity of the controls to the driver makes the cockpit feel intimate and purposeful. And there's a measure of practicality with four real doors and a waist-high, flat load floor once the rear seats are down. Although this raised platform doesn't accommodate taller items that fit in the Scion and Hyundai, you do get a handy rubberized under-floor storage bin for stashing your cordless drill, muddy work boots, or a couple of jugs of moonshine.



SCION tC

Has the right ingredients, but was cooked by an indifferent chef.

COMPARED WITH THESE other machines, the Scion tC is a brutish mallet of a muscle car. You sit low, surrounded by high doorsills, and peer over a tall dash—just like you would in a '69 Mustang Boss. Unfortunately, the rest of the interior seems equally dated. "Is that an aftermarket radio?" asked one tester. Nope, it just looks like one from the '80s. As for the engine, there's a 2.5-liter four pulled from a Toyota Camry, but in this bunch, it's like a torque-rich V-8. In the hilly countryside, the Scion could effortlessly reel in the other cars with its meaty powerband. And the raspy exhaust is a wonderfully encouraging soundtrack. The transmission is more crude than sporty, though, with longish, truck-like throws. The steering wheel has a nice fat rim, but on challenging curves, the tC couldn't hang with the Mini or the Veloster, and the tires run out of grip too soon. On the highway, the tC soaked up road blemishes that thumped our rumps in other cars. In terms of practicality, the tC clobbers the competition with the roomiest back seat. When you fold down that seat and use the tC as a college kid would—moving junk around—it's as close as one can get in this group to a pickup.



MINI COOPER

Tiny, but delivers oversize driving thrills.

THE MINI MAKES more smiles than any other car here. And it doesn't do it with horsepower. Under the hood, there's just a wee little 121-hp 1.6-liter four-cylinder engine, making the Mini the pokiest when the light turns green. But thanks to its Lilliputian dimensions and 2561-pound weight, the Cooper feels quicker than its spec sheet would suggest. When the road bends, this solid-feeling tyke is exceptionally alert and communicative. It zings where the other cars simply turn, delivering a massive rush of dopamine to your brain box. It's that fun. The Mini's

interior will make you smile, too. From the central speedometer the size of Flavor Flav's clock to the vintage appearance of the switchgear, the design is lighthearted and inspired. On the highway, the Mini's short wheelbase did not translate into a rougher ride. In fact, no matter the terrain, the Mini was firm yet comfy. So what's this athlete's Achilles' heel? The back seat fits only toddlers, and there's cargo room for just one carry-on-size suitcase. It's best to consider the Cooper a two-seater. If cargo space is a must, there are larger Minis, but naturally, they cost more.







	HYUNDAI Veloster	MINI Cooper	NISSAN Juke	SCION tC	VW Beetle
Base price	\$17,300	\$20,100	\$21,010	\$18,995	\$19,765
As tested	\$21,395	\$24,600	\$22,490	\$18,995	\$25,965
Powertrain	138 hp/123 lb-ft 1.6-liter I-4/6M	121 hp/114 lb-ft 1.6-liter I-4/6M	188 hp/177 lb-ft 1.6-liter turbo I-4/6M	180 hp/173 lb-ft 2.5-liter I-4/6M	170 hp/177 lb-ft 2.5-liter I-5/6A
Suspension (front/rear)	Strut, coil springs/ torsion beam, coil springs	Strut, coil springs/ multilink, coil springs	Strut, coil springs/ torsion beam, coil springs	Strut, coil springs/ multilink, coil springs	Strut, coil springs/ torsion beam, coil springs
Wheelbase (in.)	104.3	97.1	99.6	106.3	99.9
Length (in.)	166.1	146.6	162.4	174.0	168.4
Width (in.)	70.5	66.3	69.5	70.7	71.2
Track (front/rear)	61.5/62.0	57.4/57.8	60.0/60.0	60.6/61.4	62.2/60.9
Axle ratio	4.27:1	4.35:1	4.21:1	4.06:1	3.50:1
Brakes (front/rear)	11.0-in. disc/ 10.3-in. disc, ABS, ESC	11.0-in. disc/ 10.2-in. disc, ABS, ESC	11.7-in. disc/ 11.5-in. disc, ABS, ESC	11.7-in. disc/ 11.0-in. disc, ABS, ESC	11.3-in. disc/ 10.7-in. disc, ABS, ESC
Curb weight (lb)	2764	2561	2935	3131	3138
Power to weight (lb/hp)	20.03	21.17	15.61	17.39	18.46
Tires (front/rear)	215/45HR-17	195/55R-16	215/55R-17	225/46R-18	235/45R-17
Acceleration (sec)					
0–30 mph	3.11	3.56	2.77	2.79	3.28
0–60 mph	9.80	10.12	7.88	8.11	9.72
0–100 mph	28.39	30.10	20.26	21.61	27.42
40–70 mph	7.74	8.03	5.71	6.23	7.66
Quarter-mile (sec/mpg)	17.04 @ 81.92	17.32 @ 80.87	15.68 @ 88.89	15.88 @ 87.61	16.97 @ 82.11
Braking (ft)					
30–0 mph	28.13	27.59	30.01	29.5	30.36
60–0 mph	113.36	111.37	121.11	120.84	122.56
Sound levels (dBA)					
Idle	44.8	53.5	47.3	50.1	44.6
Full throttle	81.1	82.1	80.6	81.7	79.1
60 mph	73.7	74.5	73.9	75.4	71.1
Lane change (mph)	62.21	66.84	57.2	60.02	58.78
Skidpad (g's)	0.82	0.87	0.82	0.80	0.82
EPA fuel economy (city/hwy)	28/40	29/37	24/31	23/31	20/29
PM fuel economy (mixed/hwy)	28.74/33.51	31.70/36.58	27.75/32.41	26.37/31.26	25.03/29.61



VW BEETLE

• *Less cute than before, but still lacks an edge.*

THERE IS NO other shape in all of automobiledom, except maybe the Porsche 911, that is more recognizable than the VW Beetle. And the latest machismo-infused iteration is no exception—everyone grins as you go by. Although the newest Beetle may look tougher than the pastel one with the flower vase in your neighbor's garage, it was the softest and least edgy of our test group. The mood is more Valium than Viagra. Following our convoy through the hillocks of Ohio, the Bug wasn't happy being pushed. Even though the Beetle is only a few pounds heavier than the Scion, you can feel the avoirdupois. Back off a few notches, though, and it's a capable partner with wonderful steering. It flows through corners rather than aggressively changing direction. With its velvety-smooth ride and hushed cabin, the vee-dub excels at long highway journeys. The interior decor is upscale and very well-crafted—"nearly Audi level," according to one tester. The Beetle's 2.5-liter inline five wasn't as snappy as the powertrains of the Juke or the Scion, but it felt grunty off idle. And when you dig your spurs into the Bug, that engine produces a somewhat exotic wail. Packing stuff into the latest Beetle is now much easier due to an additional 3.4 cubic feet of luggage space. In a caravan of sport compacts, the VW is like a luxury grand-tourer.



HYUNDAI VELOSTER

• *Nails the styling and handling, but is about 30 hp short.*

HYUNDAI KNOWS HOW to make compelling family cars, competent sportsters, and plush luxury whips, but it turns out it knows how to design out-of-the-ordinary cars as well. Slide behind the wheel and you're snuggled into what looks like the cockpit of a futuristic spaceship. The materials are modern, with a 7-inch screen and big vents in the middle of a dash that resembles Optimus Prime's face. The Veloster feels feathery-light as it snakes through corners, and the steering is delicate and quick. There's crispness to its moves, but at the same time, it seems just a little tinny. Sharp bumps boom through the car's structure, and

you definitely feel them. And the Hyundai was fairly poky—we nicknamed it Captain Slow. The six-speed manual was one of the better transmissions here, but to maintain speed on a long grade, prepare to downshift every time and keep the gas floored. The Veloster's right-side-only rear door was a point of controversy. Some thought it was appropriately edgy; others would have liked a fourth door. Inside, there's a roomy back seat and a deep cargo hold. Fold the seats flat and the Veloster is a massively useful mini wagon. But most pleasing is that, at just over \$21,000 with a nav system, the Veloster is a smoking deal.





STEEL

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BY EARLY APRIL, THERE WAS SO MUCH SNOW IN ALPINE, WYO., THAT IT WAS hard to find Dan Adams's snowmobiling school, the Next Level Riding Clinics. I was looking for a big black trailer on a small side road in a boom-and-bust town on the edge of the Tetons, the 12,000-foot mountain range that sits on the state's border with Idaho. Forty minutes away, in the town of Jackson, you can find tofu burritos, a world-famous ski resort, Dick Cheney, and Sandra Bullock, plus tons of backcountry skiers who hike up untamed ridges on Teton Pass, then lay steep tracks back to their Subarus. Here, in Alpine, you see black trailers half-buried in the drifts, convenience stores, and snowmobiles.

The correct trailer was parked next to an '07 Dodge Ram Diesel with a custom black-and-white vinyl wrap, near a cinder-block garage that used to house the Alpine fire department. Adams was inside, wearing latex gloves and topping off the oil on nine Polaris 800 Pro-RMK snow machines lined up with military precision. He was maybe 5 foot 8, and about the same dimension through the chest, with a James Cagney jaw you could use for breaking bricks. The walls were plastered with logos from his sponsors, dominated by a huge crimson banner that read POLARIS: CONQUER THE TERRAIN.

Adams grew up in Jackson, where he led the mountain version of an all-American boyhood: riding a snow machine to the bus stop and growing into a pro snowboarder. Today, sledding wannabes come to him because he's starred in nearly a dozen extreme-snowmobiling movies (he helped invent the genre), because he's only the ninth guy ever to do a backflip on a snowmobile

BOLT A ROCKET TO A FUEL TANK AND YOU'VE BASICALLY GOT AN 800-CC MOUNTAIN SNOWMOBILE. SOME ALPINE PURISTS HATE THEM, BUT THE SLEDS ARE POWERING A NEW BREED OF SNOW JUNKIES—AND A DIY TAKE ON HELISKIING.

by JERRY BEILINSON

PHOTOGRAPHS BY DAVID STUBBS

■ Dan Adams, a pro rider who has appeared in multiple Slednecks extreme-snowmobiling films, says he belongs to “the part of the snowmobiling industry known for dropping cliffs.” He teaches mountain riding and avalanche safety in Wyoming’s Bridger-Teton National Forest.

("once was enough"), and because he's an all-around badass who regularly launches off monster cliffs and rips huge rooster tails in bottomless powder.

That kind of riding only became possible starting in the mid-1990s when sleds such as the Ski-Doo Summit appeared, designed to access steep terrain and deep snow. Adams's current snowmobiles are 431-pound featherweights on treads sized long—155 inches—for flotation, with 800-cc two-stroke engines.

Such adrenaline machines have muscled their way into the mountain scene throughout the American Rockies and up into British Columbia. It hasn't been a smooth transition—some backcountry skiers who once had the peaks to themselves have reacted with outrage. I can relate. Like many other skiers, hikers, and climbers who grew up in the age of sweat, I'm suspicious of anything that makes the mountains too accessible—if you can drive there, it's not wilderness, right?

Not all skiers resent the rise of the machines. A subculture of snow junkies has begun using snowmobiles to ferry each other uphill in a DIY version of helicopter skiing. In fact, I planned to get me some later in the week. I might feel guilty about it, but it comes down to core values—ultimately, I decided, there's

nothing more important than powder skiing. I just needed to work on my sled-ding skills first.

Class started with something like a smoky doughnut on a Jet Ski. We were a dozen trail miles from Adams's shop, deep in Bridger-Teton National Forest. Wade Gaughran and his son and nephew, who were finishing up a multiday clinic with Adams, were thriving, but I had already racked up a grim record: one collision with a tree (Adams had dug me out stonily), the makings of a purplish scar on my right shin, and two-thirds of a competent powder turn. "This is a boot camp on snow and I work your tail off," Adams had said. He was taking it easy on me, but my forearms were fried, and an ache was growing between my shoulder blades.

Mountain snowmobiling looks hard, and actually, it is. To turn in deep snow and to ride across hills you need to get the machine tipped up on edge, which takes timing and commitment. Adams told us to countersteer, turning the skis to the right briefly to weight the left side of the machine, then hop onto the left side of the sled, right foot on the running board, left leg way out in the snow, and pull the machine over on edge while we gave it a *brrump brrump brrump GRWAAA* of throttle. Basically, you plant

I MIGHT STOP CAR RACING. SNOWMOBILING HAS GRABBED ME LIKE NOTHING ELSE I HAVE EVER DONE.

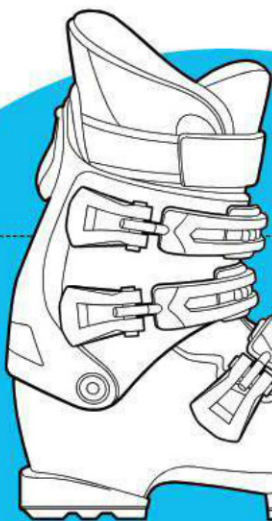
GUNSHOP OWNER WADE GAUGHNAN

your foot and the sled pivots around it.

The clutch engages at approximately 4000 rpm, and the idea is to feather the throttle to keep the engine spinning slightly above that rate. "Go as slow as possible, but just fast enough," Adams said. Unfortunately, I wasted my youth by totally ignoring dirt bikes and go-karts, and as a result I have the engine instincts of a boiled ham.

But Wade! Wade Gaughran has raced everything from Formula Fords to the 200-mph Saleen S7R supercar, and he scored a second-in-class at the 24 Hours of Daytona—he's a man who knows how to work an engine. I watched him porpoise turns through deep snow and traverse hills that would have sent me tumbling. Then he totally blew my mind by pounding straight up the slope, popping the skis into the air at the crest, and muscling the machine around to ride out of it. It was unreal. "I might stop car racing," Gaughran emailed me later. "Snowmobiling has grabbed me like nothing else I have ever done."

ALPINE TOURING GEAR



BOOTS

Alpine touring boots are lightweight cousins of conventional ski boots, with mountaineering-style lugged soles.

BINDINGS

An alpine touring binding, such as the 21-ounce Dynafit TLT Radical FT shown here, leaves the heel free to rise while the skier strides uphill, then locks it down for the descent.

CLIMBING SKINS

Removable climbing "skins" slide forward with minimum resistance but prevent the ski from sliding backward during an ascent.

AVALANCHE GEAR



Avalanche transceivers, such as the Ortovox 3+ (above, left), emit a steady signal at 457 kHz. If a skier or snowmobiler is buried in an avalanche, his companions switch their units from transmit to receive, and track the signal to commence a search. The most capable new transceivers can distinguish among several distinct signals to aid in the

case of multiple burials and calculate the approximate distance to each victim. Additional avalanche gear includes a shovel and a probe.

ILLUSTRATIONS BY PHIL LAUGHLIN

Jackson, Wyo., resident David Gonzales earns his turns at 8700 feet on Beard Mountain, a popular spot for backcountry skiing. His take on sled-skiers, who use snowmobiles on the ascent: "They should get off their ass and walk uphill."



■ MOUNTAIN SLEDS

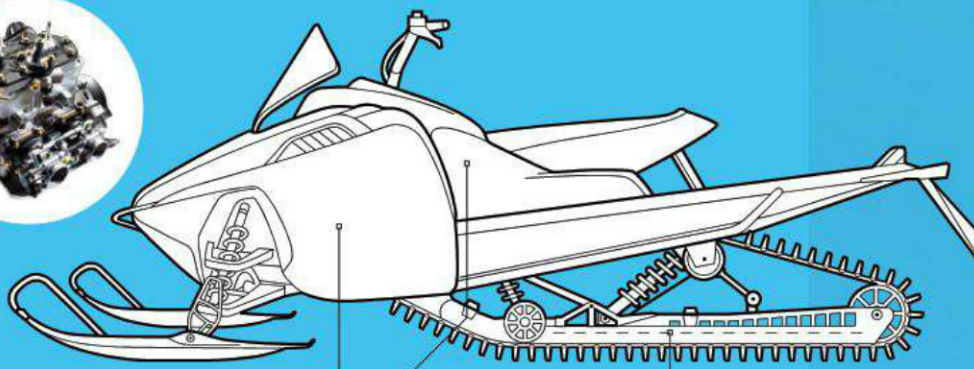
Snowmobiles meant to operate in deep snow and to climb steep terrain appeared in the 1990s, and have advanced rapidly. They now account for perhaps 20 percent of the approximately 90,000 snow machines sold in North America each winter. Mountain sleds, like the Polaris 800 Pro-RMK shown here, have long tracks for flotation, narrow builds for side-to-side agility, and a high power-to-weight ratio—a typical machine is about 450 pounds and is driven by a 150-hp engine. Riders can boost power with aftermarket turbochargers.



TWO-STROKE ENGINE

The 800-cc two-stroke engine dominates the high-performance mountain-sled world because of its light weight, though four-strokes with lower emissions have started making inroads in

other sled categories. Sophisticated fuel injection can help adjust for altitude: Engines can lose one-third of their power above 7000 feet.



NIMBLE CHASSIS

Riders rarely sit on mountain snowmobiles, so the handlebars are positioned high. The chassis is narrow, with the rider's weight shifted forward to maximize agility.

LONG TRACK

Mountain-sled tracks are long—between 144 inches and 163 inches for most models, 155 inches for this RMK. The track on a typical flatland machine is 121 inches. (The length refers to the circumference of

the track—one full revolution.) The paddles on the tread have a deep profile. They're 2.4 inches on this model, which is more than an inch longer than paddles meant for trail use.



Don Watkins loads his 2002 Polaris 800 RMK at the foot of Phillips Canyon in Wyoming after a morning of sled-skiing. "I moved to Jackson five years ago, and started getting to the backcountry gradually," he says.

and Doug fir, dumped the Pabst Blue Ribbon at the yurt, and continued up onto Beard Mountain. We were skirting the Jedediah Smith Wilderness, where motorized transport was banned in 1984, helping set the stage for conflict. By the late 1990s, arguments were flaring over where snowmobilers were allowed to ride, and tires got slashed in the parking lot. Similar altercations near Ketchum, Idaho, led to backcountry shelters being set ablaze, apparently by snowmobilers, in 2000. Frequent clashes broke out on Teton Pass. Tensions have eased, thanks in part to public meetings and the establishment of snowmobile-free zones in some classic ski spots. Still, as one local snowmobiler who's been subjected to frankly impolite gestures told me, "It's a love-hate relationship. Mainly hate."

Hurt feelings aren't the biggest risk faced by snowmobilers, though. Every day I spent in the Tetons, I relied on my companions to check avalanche conditions and choose safe terrain. But not everyone is as careful. In the U.S., avalanche statistics are maintained by the Colorado Avalanche Information Center. The data show that snowmobiling deaths climbed sharply in the mid-

MY PREVIOUS OVERNIGHT ski tours all started with an uphill slog from the truck, hauling beer and ramen noodles. But here I was, skimming across the snow, being towed with five others by a good Samaritan snowmobiler up a rolling trail on the Idaho side of the range. Once he dropped us off, we still had a steep hike to an overnight yurt (a heated, cabin-size tent on a platform) owned by Diane Verna and her husband, who run Rendezvous Backcountry Tours, an adventure company. I had stayed at this shelter 15 years earlier, when the only way to reach it was to break trail. Since then, it has been largely taken over by snowmobilers and sled-skiers. "At

least 50 to 75 percent of our customers use the machines to get their stuff to the yurt now," Diane told me, a bit sadly, as we prepared our gear.

We attached nylon climbing skins to our ski bases—the texture on the skins is angled to let the ski slide forward, but not backward, even on a steep slope. (Old-time explorers used seal pelts.) Then I clicked into my Dynafit touring bindings, which in their way were just as advanced as a Ski-Doo. They weigh barely more than 2 pounds a pair, a fraction as much as conventional ski bindings. For skiing uphill, the boot heel swings free, as in a cross-country setup; for the descent, you lock the heel down.

We climbed past lodgepole pine



1990s, with the advent of mountain sleds. Only 17 snowmobilers died in avalanches between 1950 and 1990. The total more than doubled in the next five years, and it reached 229 this past June. It now exceeds the figure for backcountry skiers, who have been exploring avalanche terrain much longer.

Snowmobilers tend to get in trouble for three reasons. The machines are heavy, which stresses the snowpack. Stability varies from one slope to another, depending on factors such as wind-loading and exposure to the sun—and sleds can move from safety to danger at highway speeds. Finally, many riders lack avalanche training, a problem Adams and some other pros are trying to tackle. “We keep getting killed because we are so damned focused on horsepower that we don’t pay attention,” Adams told me. “We have to stop being morons.”

IT WAS TWO DAYS PAST the close of the Jackson Hole ski resort, but the weather was pounding hard on the way to a

Joel Tate ripping fresh snow two days after nearby Jackson Hole Mountain Resort closed for the season, on April 3, 2011. Tate, a chef in Jackson, Wyo., says, “The Canadians are definitely more open to sled-skiing, but it’s starting to even out around here.” He rides a 2009 Ski-Doo Summit 800.

record 700-inch-plus snow year in the mountains. In the gas station at the foot of Teton Pass, the dyed-blond, hard-boiled woman ruling the register was talking down a young guy, maybe in his early 20s, who had just stalled and slid backward down the pass. He was crying literal tears at the idea of trying again in the silver, rear-wheel-drive coupe I saw out front. While she gave him detour directions, I grabbed my coffee and joined local snowboarder Don Watkins, who was driving a borrowed F-250 with his Polaris and snowboard in the bed. In front of us somewhere in the storm was his buddy’s truck, loaded with a Ski-Doo and ski gear. We torqued steadily up through the slippery mess to reach the base of Phillips Canyon, a local hotspot for sled-skiing.

At a dirt turnout, we loaded the ski gear onto the snowmobiles and rode

“Canadian style.” Watkins stood on the right running board to control the throttle while I balanced on the left, expertly not touching anything and following directions. (“Lean out the left. Okay, stand up. Lean left again—not that much!”) I peered over into a wide, deep well in the snow, onto the green roof of one of those sign-in boards posted at National Forest trailheads. We sped through meadows, then slowed to make turns through the trees, branches slapping my helmet from time to time while my legs pumped to absorb the changing terrain. It was fun.

After 30 minutes, we reached the treeless floor of a cirque at 9200 feet. We were miles into the backcountry—at a location it would have taken all morning to reach on skis. Glades and cliffs rose 1000 feet or so on three sides—put a lift system in here and you’d have Vail.

We gunned the machines to the top of the ridge and unloaded the gear. Watkins and his friend Joel Tate rode both snowmobiles back the way we’d come, and returned 10 minutes later, having left one of the machines at the bottom. For some reason an old rope was dangling from a branch over the slope, like

it was a swimming hole. I watched as Watkins dove in on his snowboard, trailing fingers through snow. When I followed, the snow was heavy, and I entered that dreamy winter world where grav-

ity works at half-speed. The top layer sloughed off and flowed around me, piling up against my calf muscles when I turned to let it pass. Tate—a man of enormously wide skis with a cowboy mustache and plugs in his earlobes—blasted by me in an explosion of powder, like some groovy 1970s ski poster. I surfed up over a crest in the terrain, skimming the surface of the snow. And when I caught up, Tate was already at the lower snowmobile, getting ready to ferry us back to the top.

We skied several runs—faster than I could have done a single lap if I were climbing for my turns. We saw no other snowmobilers and we saw no other skiers. Each time we reached the bottom, the tracks up high had filled in. And so we’d start up the engines, and do it again.

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Removing Yourself From the Internet

LEAVING THE WEB BEHIND MIGHT JUST BE THE KEY TO YOUR PRIVACY (AND SANITY). BY JOHN HERRMAN

➡ If you've ever used the Internet, you have an online identity. Maybe it's slight: a Hotmail account here, a comment on a news story there. Or maybe you've been more prolific, leaving a trail of usernames, accounts, messages, and profiles across the digital landscape. In any case, an active Internet user owes it to himself to do a bit of self-Googleing. What you'll find will be both enlightening and humbling—even worrying.

Unease about your online identity shouldn't be limited to how much information is publicly available. Online

INSIDE

×

CLEANING YOUR GADGETS + HDTV WEIRDNESS + PRIVACY TOOLS

advertising is the engine that drives the Internet's largest sites, including Google and Facebook, and it depends on your personal—and allegedly private—data for fuel. "The government, companies, and marketers all want us to share as much information as possible because that's what's good for them," says Rebecca Jeschke of the Electronic Frontier Foundation, "and it's time to think of what's good for us."

While most Internet users seem fine with privacy tradeoffs, the lack of control will lead some to consider the nuclear option: total Internet evacuation. But taking yourself offline isn't as simple as logging out—it requires a little bit of work. Here's how.

Popular Sites

➔ **When a website is new**, the last thing its creators are thinking about is how to help users leave. Thankfully, many of the Internet's largest identity properties—Facebook, Google, Amazon, and Microsoft—are fairly mature and have evolved enough to offer well-defined—if well-hidden—escape plans.

If you've ever used Gmail, Google Docs, Google+, or Picasa, to name a few, then you have a Google account. Google accounts can contain an astounding amount of personal data—check google.com/dashboard to see exactly how much—but removing it is a straightforward process. Before you hit the switch, be sure to back up any information you want to keep—a Google account can be recovered for only a few months after its deletion. Google doesn't have a software tool for exporting data from its services, but most services have their own, typically found under the settings menu on the upper-right-hand side of the screen. As with other webmail services, the easiest way to back up your Live or Hotmail messages is to add your account to a mail app such as Outlook or Apple's Mail before deletion—this will have the added benefit of backing up your contacts.

Once you've copied your important data offline, navigate to your Google



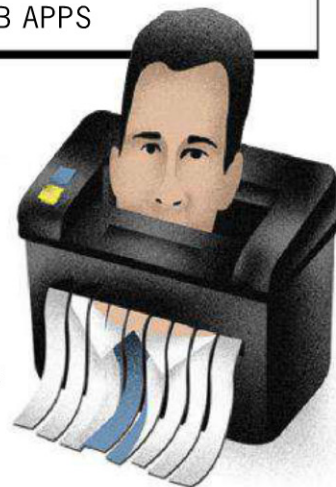
THE KILL SWITCH

A WEB APP TO END ALL WEB APPS

➔ Signing up for social media sites is, by design, almost entirely frictionless. Three or four clicks will get you in the door, but finding your way out takes significantly more time and effort. The Web 2.0 Suicide Machine (tagline: Meet Your Real Neighbors Again) is a one-shot tool for deleting your profiles from some of the largest social sites on the Web, including Twitter, Myspace, LinkedIn, and Facebook.

The tool was released last year by the New Media Lab in Rotterdam, the Netherlands, and still lives up to its name—with one exception. Facebook has taken action to disable the site's "suicide" script, and even sent the creators a stern cease-and-desist letter, demanding that Facebook be exempted from its deletion tools.

Among the concerns included in Facebook's legal letter? "[T]he protection of users' privacy."



account dashboard (google.com/accounts). Next to My Products, click Edit. Then select Close Account and Delete All Services and Info Associated With It. You'll be presented with a list of Google services that you've used in the past. (In my case, this included three that I didn't remember signing up for.) Check the box next to each, along with the two are-you-really-sure boxes at the bottom, and select Delete Google Account. The account will be instantly wiped from the public Internet, but the company warns on its website that "residual . . . accounts may take up to 60 days to be deleted from our active servers and may remain in our backup systems," but not be accessible in any way, "for an additional period of time."

Until 2008, there was no obvious way to permanently delete your information from Facebook. Instead, there was a Deactivate option only, which removed your profile from public view but left it on Facebook's servers indefinitely. Thousands complained, so Facebook built a tool for permanently and instantly deleting user data—then promptly hid it away in the site's Help section. To access it, log in to Facebook, navigate to facebook.com/help, and type "delete my account" in the search box. The top result will link you to the deletion page. Click Submit and confirm your choice, and you're done. While Facebook doesn't offer much help for backing up your data—a particular concern if you use Facebook to hold your photo collection—there are a number of free Facebook apps designed to archive your albums, such as Facebook Exporter for iPhoto and FBPhotoExport.

To pull yourself free from Microsoft's services, go to account.live.com and scroll to the bottom of the page. Under the Other Options header, click Close Account. On the following page, reenter your account password and press Yes. Unfortunately, there is no account-wide export option.

Closing an Amazon account is a more roundabout process. Click Help in the upper-right-hand corner of any page on amazon.com and search "closing your account." On the resulting page, pick Contact Us, then click on Something Else. Below that, select Account Settings from the menu, then Close My Account. At the bottom of the page, click Send Us an Email, fill out the form, and send.

Smaller Sites

➔ **Most reputable websites will offer** some sort of account deletion option. Smaller sites that have posted (or more likely, reposted) your data without your

permission can prove more difficult; after all, the owners never had your permission to republish your blog posts, photos, or videos in the first place. Finding this type of information—or derogatory and misrepresentative comments about you—is no more difficult than doing a search on Google or Bing. (Be sure to place quotation marks around your name.)

Searching for yourself isn't about narcissism; it's not unusual for job recruiters, current employers, or even potential dates to vet new acquaintances on search engines. A misleading search result or libelous information could cause serious distress and do damage to your reputation.

On a smaller site, sending a direct request to a webmaster to pull infringing or upsetting material is your best course of action. If there is no prominently listed contact information for the site's operator, or if you aren't able to get a response from the listed address or phone number, you can find direct contact information for the site's administrator by conducting a search on whois.net. Domain owners are required by the Internet Corporation for Assigned Names and Numbers to supply contact information for Whois searches, including a phone number. This may at least get you on the phone with someone or give you a working email address. Whether that will be of any help is a different story.

If a site refuses to take down content that belongs to you, you can try sending a takedown notice. Under the Digital Millennium Copyright Act (DMCA), you are entitled to have infringing content—images, text, or video that you own, specifically—taken down. There are a number of forms available online for submitting DMCA notices to Internet hosting companies; there are even forms for asking Google, Yahoo, and Bing to remove content from their search results. While these forms don't guarantee cooperation, the mere threat of legal action will at least be enough to get a site owner's attention. If your DMCA notice doesn't get a response, it might be time to talk to a lawyer.

The Data That Won't Die

➔ **It's easy to tell when your data** has been removed from public display; if you can't find it anymore, then it's effectively gone. Finding out whether or not a company is still holding your data privately—or selling it to third parties—may be impossible. "There's no way to verify that your information has been deleted," Jeschke says, nor is there an overarching law or regulation governing data retention. Some data simply can't be reclaimed; you relinquished control the moment you hit Submit, after you clicked past that 50-page license agreement.

This is a valuable lesson, and while it might not help you seize full control of your online identity, it's instructive. When you sign up with a service, make sure you trust its parent company and understand what data you're giving up. To sign up with Google or Facebook is to sell yourself in a literal way; as an astute (and anonymous) poster on the news site MetaFilter wrote, "If you are not paying for it, you're not the customer; you're the product being sold."

PM



SECURITY BLANKETS

CHOOSING AN ONLINE PRIVACY TOOL

Leaving the Internet isn't for everyone, but staying doesn't have to mean giving up on privacy and data security. Here are three tools to give you online peace of mind, from the somewhat discreet to the ultra-secure.

PRIVACY TOOLS

PRIVATE BROWSING

This feature is included in most new Internet browsers and goes by a few different titles: Private mode, Incognito mode, and InPrivate. All these names are a bit of an overreach: This mode only prevents Web browsers from collecting history and cookies. It keeps other users of your computer from seeing what you've been doing (buying gifts being the most palatable example); it won't shield your IP address or existing cookies from external sites.

VIRTUAL PRIVATE NETWORKS

Paid virtual private network (VPN) services route your Internet traffic through an intermediary, masking your computer's address from the sites you visit. Sites will, however, still be able to deposit tracking cookies on your computer, and your browser will still be prone to exploits and viruses. VPNs reroute all Internet traffic on your computer, not just from Web browsers, which makes them popular with file sharers. Reputable services include WiTopia and Blacklog.

COCOON (GETCOCOON.COM)

This service is a plug-in for the free Firefox browser that combines the advantages of private browsing and a VPN with extra security features. Traffic is routed through remote servers and made anonymous, and all incoming files—downloads or websites—are scanned for viruses and malware. Other features include throwaway email addresses for spam prevention, and full portability, so you can access your Cocoon account from other computers.

SECURITY EVALUATION



MINIMAL



MODERATE



PARANOID

Digital Clinic

by John Herrman

Q+A



Q

Cleaning Your Gadgets

As someone who likes to keep things tidy, I find my grimy electronics collection is an embarrassment. How can I clean my gadgets without damaging them?

A According to a study by the London School of Hygiene & Tropical Medicine, 92 percent of tested cell-phones were contaminated with potentially harmful bacteria, and one in six tested positive for *E. coli*, most likely originating from—yep, everybody does it—bathroom phone fiddling. But you don't need a microscope to know that gadgets are filth magnets. Dust and grease accumulate on screens with frightening speed. Hairs and crumbs find cracks, seams, and nooks with deadly accuracy. Once-gleaming surfaces fall victim to discolorations of mysterious provenance. Clean gadgets look nice, of course. Sterile gadgets could help you through cold season.

First things first: Barring a few specialty items, most of the things you need to clean your electronics are either already in your home or available at a hardware store. "Electronics cleaning cloths" and "electronics cleaner" solutions are rebranded, overpriced variations on conventional household products. Most of your gadget cleaning can be done with three tools: microfiber chamois or pure cotton cloths, distilled water, and isopropyl alcohol.

Cleaning any screen should start with a light, dry wipe down with a microfiber cloth. (It's best to avoid paper towels, which are more abrasive and prone to dragging particulate dirt across the

DIY

Tech DIGITAL CLINIC Q+A

screen, scratching its coating.) Once the screen is dusted, soak a fresh chamois in distilled water—hard tap water will leave streaks—squeeze it out, and run it across the screen from one side to the other. At the end of every second or third stroke, refold the cloth so that a clean portion is touching the screen. A cloth tainted with abrasive debris will do more harm than good. Wipe any beaded water dry with a fresh cloth. For stubborn finger smudges or layers of tar deposited by smoke, a 50/50 mix of isopropyl alcohol and distilled water will cut through almost anything without being so corrosive as to damage the screen. One caveat: Some portable gadgets, such as the iPhone and iPad, have special self-cleaning, or oleophobic, screen coatings that can be damaged by alcohol. With those devices, stick to water. In all cases, keep clear of the very edges of the screens, which are dangerous entry points for moisture. Instead, use a dry cotton swab to remove dirt from recessed edges.

This 50/50 alcohol mix is a do-it-all cleaning fluid: Wipe it over keyboards, mice, remotes, and other plastic and metal surfaces to quickly kill bacteria and cut dirt and grease buildup. To clear hard-to-reach dust and debris—take a good, hard look between your keyboard's keys—get a can of compressed air, which will blast free all but the most stubborn particles. You can buy it at any office retailer for about \$10. But keep the can upright—using compressed air upside down will spray your gadgets with a mist of difluoroethane, a liquid fluorocarbon.

One device that deserves specialty equipment is your camera.

Cleaning a lens with a contaminated cloth or a shirtsleeve can degrade delicate lens coatings, so invest in Lenspen (\$15), which has a concave chamois tip treated with lens polish, or a similar product. These lens cleaners also come with retractable antistatic brushes for cleaning dust from image sensors; they just so happen to be great tools for clearing ventilation grilles in laptops, desktop computers, and game consoles.

Too Real for TV ➔ My new TV is great, with one catch: Some movies look weird. Something about the motion is strange, almost as if the movie is animated. What's going on?

Most films are recorded at 24 frames per second, while TV is usually recorded at 60 frames per second—more faithful to human vision, but less cinematic-looking. What's causing the effect is something called motion interpolation, which takes low-frame-rate content and converts it to higher frame rates by inserting computer-synthesized frames in between real ones. To turn off this feature, you'll have to figure out what it's called: Sony's version is MotionFlow, Vizio's is MEMC, LG's goes by the name TruMotion, Samsung labels it Auto Motion, and Toshiba's is ClearScan.

That's not to imply that high frame rates are inherently bad. In fact, Peter Jackson is filming his upcoming adaptation of *The Hobbit* at 48 frames per second, and James Cameron plans to shoot the sequels to *Avatar* at high frame rates as well. As he explained at a POPULAR MECHANICS Breakthrough Awards panel in October, "Being able to show movies at 48 or 60 frames a second would really improve the way they look. We've adapted to [low frame rates], and we expect movies to look the way they do, but every time you pan the camera, the whole image strobes." Take heed: In movie technology, where Cameron goes, many others will follow.

PM

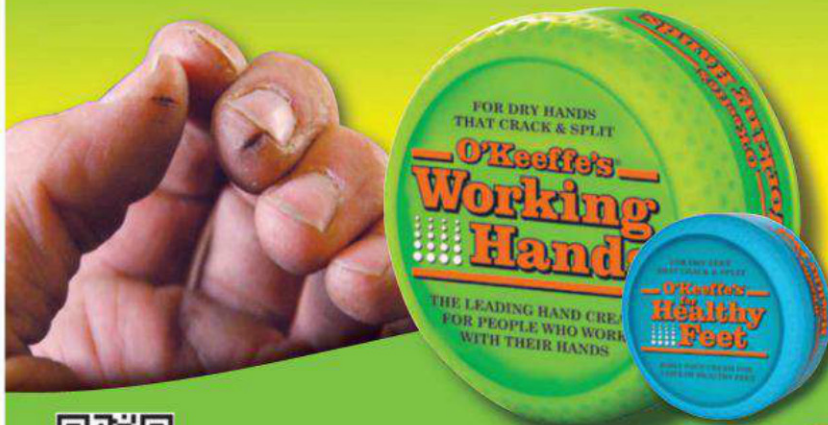
Got a technology problem?

Ask John about it. Send your questions to pmdigitalclinic@hearst.com. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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DIY

Home**Simply Perfect**THIS EASY-TO-BUILD TWO-DOOR CABINET
CLEARS CLUTTER AND SPRUCES UP A ROOM.

BY JOSEPH TRUINI

➔ **One basic thing** can make the difference between a room looking cluttered or put-together: storage. Of course, getting rid of excess stuff also helps. But even after you've pared down your possessions, having an attractive place to stash essential items is key. Enter the two-door cabinet, a minimalist solution that's been around for centuries. Our take on the classic fits just about anywhere, and its panels can be made from a variety of materials—metal mesh, glass, or wall-papered plywood, for example—to suit your decorative palette. Like many PM projects, this one is simple; a reasonably skilled woodworker with a small table saw, cordless drill, and pocket-screw kit could build it over the course of two weekends, max. Here's how.

**INSIDE**

✕ REPAIR GRANITE COUNTERTOPS + FIX CHAIRS + DEAL WITH ROCKS

STYLING BY MICHELE ERVIN

PHOTOGRAPH BY SETH SMOOT

Cabinet Case and Doors

➔ **Start by cutting** the birch plywood for the cabinet sides, top, bottom, shelves, and cleats. I used a table saw, but a circular saw and a straightedge guide would also do the trick.

Next, cut the rabbets on the inside edges of the side panels with a router and a $\frac{3}{8}$ -inch rabbeting bit [1]. When that's done, use a drill to bore the shelf-peg holes in the side panels [2].

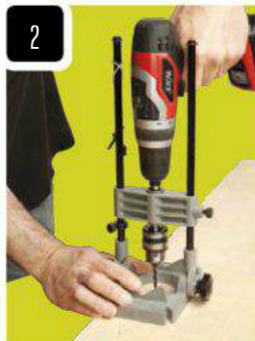
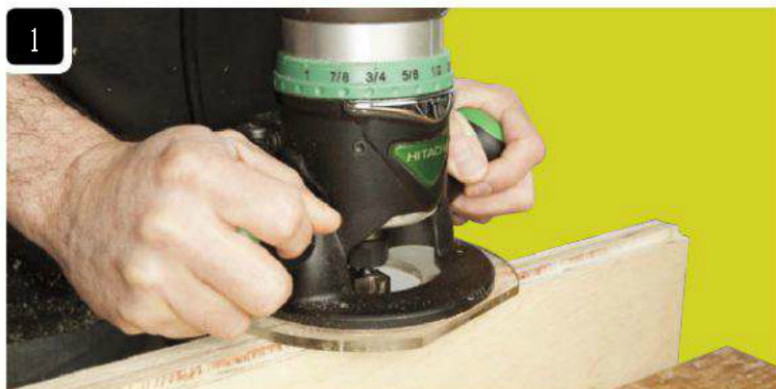
Use a pocket-hole jig to make the screw holes in the bottom of the cabinet, then fasten the bottom to the sides [3]. Screw the cleats between the two side panels [4], and complete the case box by cutting the back panel to size and nailing it in place.

Four pieces of wood make up the face frame. Rip and crosscut these pieces, then glue and nail them to the case using a pneumatic pin nailer and 23-gauge headless pins [5]. Put the hardwood edging on the plywood top panel using the same method. Now place the cabinet top—made of material such as maple-faced and -trimmed plywood—in position, and drive screws through the cleats into its bottom [6].

Rip and crosscut the pieces for the doorframes and—again using the router and rabbeting bit—cut the panel rabbet on the inside edges of the frame.

Bore a pair of pocket-screw holes at the end of each door rail, then drive the screws. Wipe some carpenter's glue onto a maple pocket-screw plug and insert one into each hole.

Now it's time to choose the panels you'll use. Cut metal-mesh panels to size with aviation snips, slip them into the rabbets, and secure with screen molding nailed to the doorframe (see Panel Discussion). If, on the other hand, you use $\frac{1}{4}$ -inch plywood covered with wallpaper (see preceding page), secure the panel with glass-door retainer clips (rockler.com). Regardless of the panel material, keep in mind that you may need to adjust the rabbet depth and width to suit. For thin panels, we found that a rabbet that's $\frac{3}{8}$ inch deep and $\frac{1}{2}$ inch wide works pretty well.



[1] Clamp two panels together for a wider surface and rout the rabbet for the back and side panels.

[2] Use a portable drill guide and bore the holes for the shelf pins in the cabinet sides.

[3] Bore four pocket-screw holes in the bottom, then drive pocket screws through the bottom into the cabinet sides.

[4] Cut the cleats to fit between the cabinet sides, and drive countersunk screws through the side into the ends of the cleats.

[5] Simply glue and nail the face frame to the front cleat, the cabinet sides, and the bottom shelf.

[6] The top consists of a plywood panel and three maple edging strips dimensioned to drop down onto the cabinet; it partially covers the top face frame rail, which is $\frac{1}{2}$ inch wider than the other face frame parts. Set the top on the cabinet and drive screws up through the cleats into it.

Fasten two self-closing cabinet-door hinges to each door, then lay the cabinet on its back and set the doors on the face frame. Center the doors on the cabinet with a 1/8-inch space between them. Bore pilot holes through the hinges into the face frame and screw the hinges to the frame.

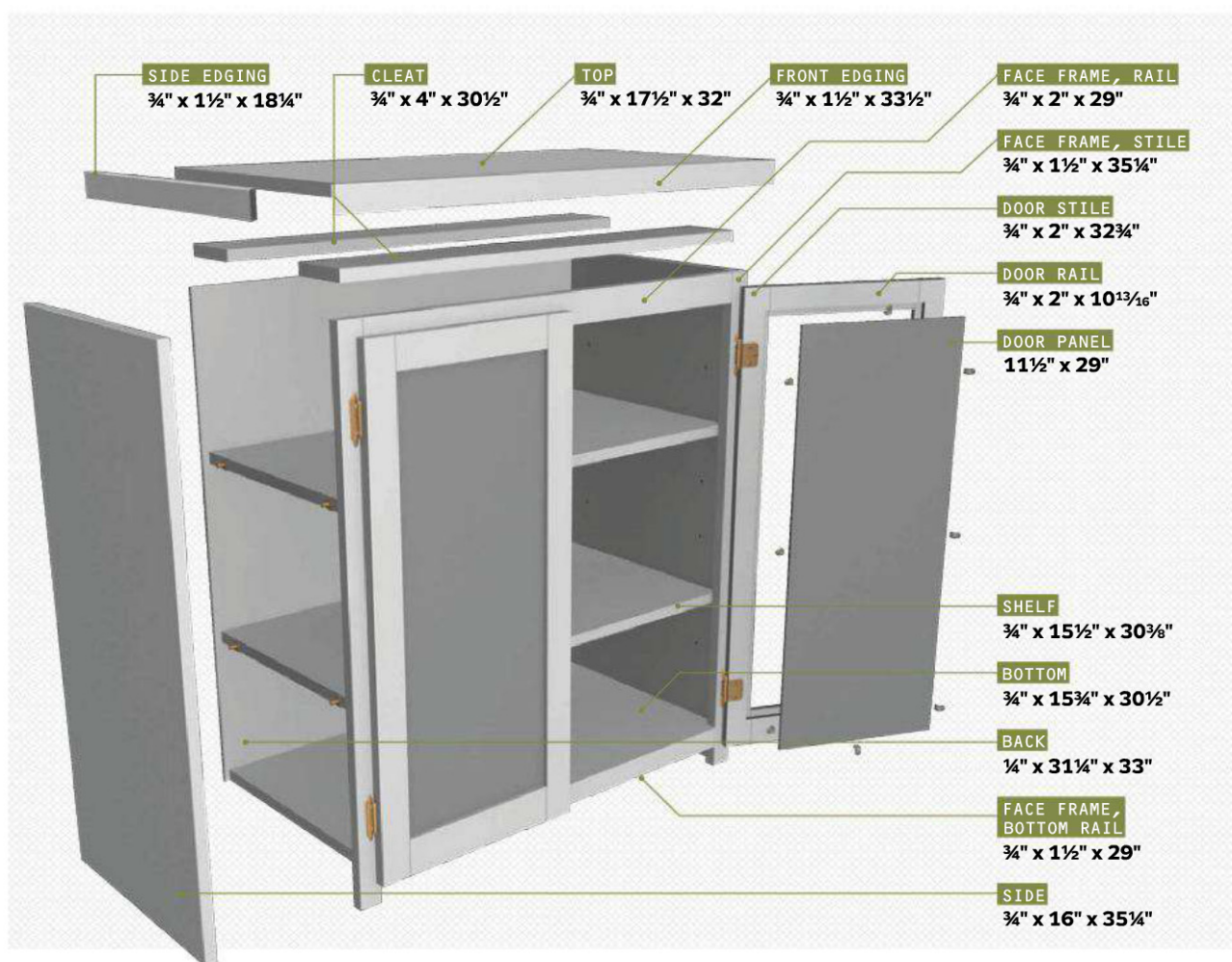
Finishing Touches

➔ **Set a clothes iron** at high (cotton), with no steam, and apply iron-on maple veneer banding to the front of each shelf. Firmly rub the veneer with a wood block to secure the bond. After the veneer has cooled, use scissors and a sanding block, respectively, to cut and hone the veneer to fit.

Fill nail holes with wood putty, let dry, then lightly sand all surfaces with 120-grit sandpaper. Wipe off dust with a tack cloth, and apply two coats of satin polyurethane varnish. If you'd prefer to stain the cabinet, apply two coats, wait for them to dry, then apply varnish.

Press metal shelf pegs into the holes in the cabinet sides, then set the shelves in place.

PM



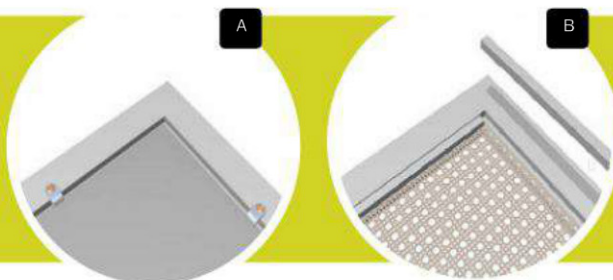
Panel Discussion

A

Solid: Set the panel into a rabbet cut on the door's back and secure it with glass-door retainer clips (rockler.com) held with screws.

B

Metal mesh: Secure the panel with 3/8" x 3/8" beaded screen trim. Drive wire brads or pneumatic headless pins through the molding's side or front.



Homeowners Clinic

by Roy Berendsohn

Q+A

Q

Sit Tight

At least half of the wood chairs we own are wobbly. We've tried every adhesive we can think of to fix them—white glue, yellow glue, epoxy, polyurethane. Nothing seems to work. What do you suggest we do?

A Glue alone won't work. It's natural to think that it would do the job—like most homeowners, you squirted some glue into a loose joint and hoped for the best. But unfortunately, applying a thick glob of adhesive is actually counterproductive. Wood adhesives work best when you apply a thin film of the sticky stuff to both sides of a joint, then use pressure to force the parts together. Furthermore, you almost always have to rebuild the joint, reinforce it, or disassemble it and remove adhesives from previous repairs to get it to fit properly.

Let's take a closer look at this. For a chair to be moved around easily, it has to be lightly built. Yet the loads a chair accommodates are severe. A chair may weigh 10 pounds, but it has to support a person 10 times or more its own weight. And that person is a highly dynamic load. He or she may sit, stand, twist, or shift on the chair, putting its joints and parts through strenuous cycles.

Compare that with cabinets, chests, and dressers. This furniture is overbuilt relative to the weight it holds. A chest or dresser can easily weigh 50 to 100 pounds yet hold less than 30 pounds of clothing. Aside from sliding drawers, most of the time the load is stationary. You can see why chair joints fail, sometimes catastrophically.

One relatively easy solution for chairs that have only one loose joint is to bore a pocket hole in a discreet location, spread a thin film of professional-quality wood glue on the loose parts, and then drive a pocket screw to lock the joint together. I've



It takes a stubby drill driver or a right-angle attachment to install a pocket screw between a chair's parts. Save space by inserting the bit directly in the chuck rather than in a magnetic bit holder.



done this to a couple of chairs in my house, and I've been pleased with how well the repair has stood up.

This technique won't work if there's adhesive from a previous repair on the joint; it creates an undesirable surface on which to spread new glue. And this works only for chairs with parts that are thick enough or wide enough to withstand the amount of wood that is removed when a pocket hole is bored. Finally, don't use this method on an antique; you could diminish its value.

With a chair that has a number of severely loose joints, label all the parts with masking tape, then disassemble them using a clamp with a reversible jaw, known as a spreader. After you have the parts separated, carefully scrape away the dried adhesive, then repair, rebuild, and reinforce the joints. Finally, reassemble the chair using professional-quality wood glue. If you're not an experienced woodworker, take a course at a community college or craft center before undertaking this project.

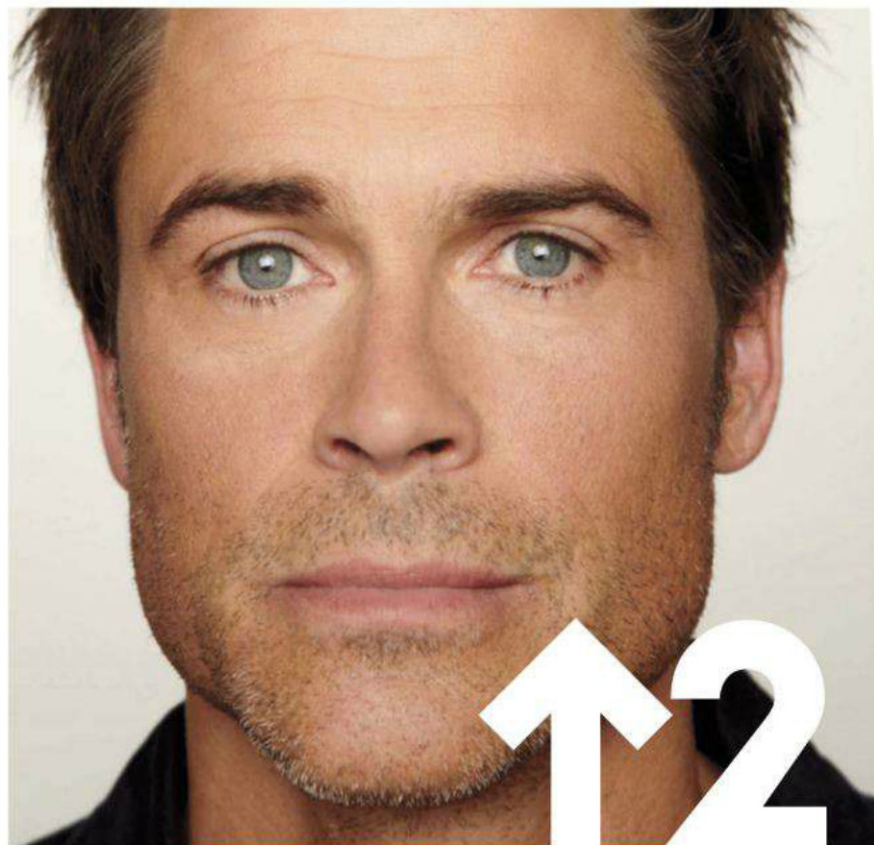
Seeing Spots ➤ Where I live in the Southwest, my lawn sprinklers leave tough, spotty residue on my basement windows. I've tried glass cleaners, carbonated soft drinks, vinegar, and acid-based cleaners that are supposed to remove mineral scale. Nothing works. What else can I try?

I'd try Spot-X Hard Water Stain & Spot Remover, a cleaner formulated to mechanically (not chemically) remove mineral residue from hard surfaces such as glass, mirrors, porcelain, and chrome. Its gentle abrasive action is by means of powdered walnut shell, specifically the *Juglans regia*, or English (European) walnut. An 8.75-ounce bottle with a synthetic applicator pad costs about \$12 plus shipping. In the meantime, you may want to swap those sprinkler heads or adjust their pattern so that they don't spray the windows. Consider it a few ounces of prevention.

Rock On ➤ I'm a part-time farmer in Illinois and regularly deal with rock removal. I'd appreciate any information on how I can do this better.

Several years ago, we took a crash course in rock removal by trying out two new technologies ("How to Blow Up a Rock in 6 Steps," at popularmechanics.com). One was the Micro-Blaster, a small-scale setup that you don't need a license to use. You take a rotary hammer and drill into a rock, clean the dust and debris out of the hole, and insert a Micro-Blaster cartridge or two into the opening. A pneumatic firing pin detonates the charge. It works like a charm. (Don't forget eye and ear protection.) You can get Micro-Blaster kits through specialty supply houses that sell to construction and mining companies.

We also had good results with a new type of rental rock-cutting saw made by Husqvarna. Called the Cut-n-Break, it slices through rock and concrete the way a circular saw severs lumber.



SONS & DAUGHTERS

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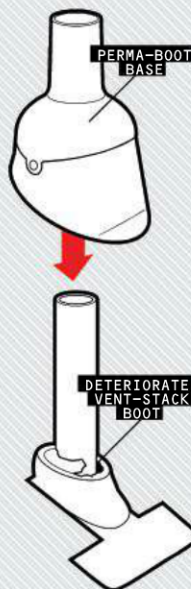


PROBLEM SOLVED

FIXING VENT-STACK LEAKS

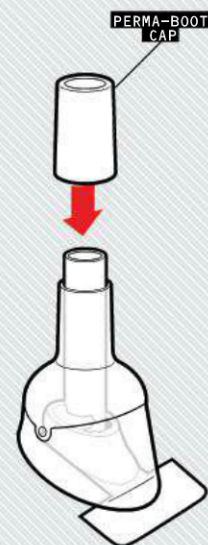


Plumbing vent stacks are a notorious source of roof leaks. The rubber boot at their base weathers away, leaving a gap that lets in melted snow and rain. The Perma-Boot (\$20) is a two-piece ABS plastic cover that neatly solves the problem. — R.B.



Step 1

Slip the hinged base over the weathered boot and adjust it to the roof slope.



Step 2

Slip the cap over the base and glue it on with the adhesive provided.

After the fun of blasting and cutting is finished, you'll be left with the hard work of dragging away the rubble. Always remember that your pulling gear is no stronger than the proverbial weakest link, whether that's a Grade 30 chain with a working load limit of 4500 pounds or a piece of rope that breaks when stressed with an unknown amount of force. I learned the hard way how dangerous rock pulling can be. While dragging a boulder with a four-wheel-drive truck, I snapped a high-strength rope, which gave off a crack like a .22 rifle. But as startling as that was, it was nothing compared with how viciously the broken rope flew through the air. Onlookers dove for cover. Despite my carelessness, no one was hurt. The first rule in pulling heavy loads is to clear the area of bystanders. A rope that breaks and whips through the air is dangerous, but a flying piece of chain or hook, or a snapped steel cable, is downright deadly.

Paint as You Go — My husband and I are building a white picket fence to go in front of our house. I'm the painter in our family, and I'd like to be able to take the fence sections into the garage to paint. Can these be made removable?

I think that's a good idea. Bolting the picket sections to the posts or crossrails would let you take them into the garage to paint when it's raining, for example. I would number the sections to ensure they go back on the posts in the original position.

You should use hot-dipped galvanized bolts to hold the fence sections to the posts. This will prevent rust stains caused by ordinary steel hardware from ruining your paint job. Hot-dipped means that the bolts, nuts, and washers are submerged in molten

zinc, which bonds to the steel, creating an unmatched electrochemical and mechanical alloy layer. This bond makes the hardware highly corrosion-resistant. Other plating methods—such as tumbling fasteners in hot zinc particles—are not as effective.

Repairing Granite ➔ **We have a granite counter with a small chip. Is there a repair material that can fill the damage so that it won't be noticeable?**

You can fill in the damaged area, and it's likely that you'll be the only person who knows the counter has been repaired. Your best bet is to get a product such as the Natural Stone Repair Kit from Bonstone, a manufacturer of adhesives and fillers for stone, tile, and concrete. The kit includes three different-colored tints, adhesives, and application tools. You should be able to blend these materials to get a very close match.

"The key when making a repair like this is to overfill the chipped area slightly, then slice off the excess while the material is still moist," according to Bonstone's Kevin Thorstad. "Use one of the razor blades from the kit, then let the area cure."

The filler dries to a shiny finish; you don't have to polish it to match the surrounding surface. A professional can apply a layer of cyanoacrylate glue (superglue) to the surface of the repair after it's dry and polish the entire counter to blend it in. Perfection will cost you, though. It always does. Expect to pay anywhere from a couple of hundred dollars up to \$500. A repair kit, on the other hand, costs less than \$40.

Wobbly Sump Pump ➔ **I've got a basement where the sump pump runs constantly. The pump wobbles around in the pit and makes a racket. Does it harm the pump to move around? Also, what can I do to make it quieter?**

A little vibration is one thing, but a pump shouldn't wiggle like a bowl of Jell-O. You may need to replace the pump or just install it better. More about that in a moment. The fact that it runs constantly may be a bad sign. It may be cycling the water, not removing it. Be sure the pipe leading from the pump discharges as far as possible from the foundation; ditto for your gutter downspouts. Finally, the ground around the house should slope away on all sides.

The movement (and noise) probably indicate that the pump is worn out. Also, if the pump isn't supported properly, that will certainly cause it to shake, rattle, and roll, and that's liable to be transmitted to the discharge pipe and to the house's framing. The pump should be sitting on the bottom of the sump, not perched atop a pile of bricks or rocks. I fished out a sump pump once and found it was sitting on a pile of garbage. I guess the guy who put it in cut the first length of discharge pipe too short and simply propped up the pump on whatever was lying on the basement floor at the time. I discovered chunks of concrete, rotted lumber, plumbing scraps, and slimy stuff that I couldn't even identify. You may have to roll up your sleeves, get down on your belly, reach into the black lagoon, and grope around. If the sump bottom is just mud, obviously that's no good either. In that case, line the bottom with washed ¾-inch gravel.

That leaves the noise. Consider a high-quality pump, especially a cast-iron model, such as a Zoeller. These are inherently quiet because they're robustly built. You should secure the discharge pipe with brackets where it passes along the wall and floor framing—maybe even isolate the pipe and brackets with rubber strips to dampen vibration. Finally, locate the check valve on the discharge pipe as close to the pump as you can. Putting it far away causes a large slug of water to reenter when the pump shuts off. That could be enough water to reactivate the pump.

PM

Got a home-maintenance or repair problem? Ask Roy about it.

Send your questions to pmhomeclinic@hearst.com or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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PM Saturday

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Light as Iron

COMMON PIPE FITTINGS AND A TOUCH-START SWITCH
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BY WILLIAM GURSTELLE

Scrap $\frac{3}{4}$ -inch iron pipe, a few fittings, and some simple wiring make up this rugged touch-activated lamp.

1 → PREP PARTS Scrap ¾-inch iron pipe and fittings make this stable, rugged lamp. Get a 12-inch nipple, three tee fittings, four 90-degree elbows, one 45-degree elbow, 11 close nipples, four pipe caps, a candelabra socket, a cord, a bulb, a worklight's shade, and a touch-dimmer switch. Use a cobalt bit to drill a ⅜-inch hole in a tee, opposite its center opening. Pull 18 inches of cord through the hole and the tee's center opening.

2 → WIRE THE IRON Screw together the 12-inch nipple, the

45-degree elbow fitting, and a close nipple. Fish the lamp cord through this assembly. Screw the open end of the 12-inch nipple into the drilled tee fitting's opening.

3 → FINISH THE LAMP Wire the lamp socket base to the cord at the nontee end of the 12-inch nipple. Make sure all electrical connections are insulated and not touching pipe. Gently pull the cord from its plug end, tightening up slack until the lamp socket base is even with the nipple's edge. Use a hose clamp

to clip the worklight's shade to the 45-degree elbow.

4 → GIVE IT LEGS Assemble the lamp base using two tees, four 90-degree elbows, and 10 close nipples. Insert nipples into the openings of the tee and elbow fittings. Finger-tighten the connections. To make feet, screw the pipe-cap fittings to the nipples.

5 → LIGHT THE PIPES Screw in a bulb. Plug the cord into the touch dimmer and plug it into an outlet. Hit a pipe to turn it on.



Be Prepared to Solder → Earn the Boy Scouts' new Robotics merit badge at a workshop Jan. 8 with Chibots, a Schaumburg, Ill., shop. Scouts learn to program sensors, take measurements, and maintain an engineering notebook.

Shovel Safely → Snow shoveling sends 11,500 folks to the ER annually. "Don't throw the snow," Michigan physical therapist Jeff Smith says. Just squat, choke down on the shovel, and push small scoops.

Carve Powder → Help make the icy bricks used for the Budweiser International Snow Sculpture Championships during the contest's Technical Week, Jan. 16 to 20, in Breckenridge, Colo. See finished art Jan. 30 to Feb. 4.

Attract Winter Birds → Use your discarded Christmas tree as a bird feeder. Set it against the south side of the house in a bucket of sand. Put birdseed and berries on branches near the trunk. Enjoy songbirds, then in the spring, mulch the tree.

Learn to Be Handy → Bay Area homeowners pick up the basics of drywall patching, lock replacement, faucet installation, and window repair from local pros at Berkeley, Calif.'s Building Education Center on Jan. 8 and 9.

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DIY

AutoSaturday
Mechanic

Running on (Natural) Gas

WHAT GOES INTO A NATURAL GAS VEHICLE, AND DOES CONVERTING YOURS MAKE SENSE? BY BEN WOJDYLA

➔ **Natural gas** has been used in our homes for generations. Americans use it to run water heaters, home furnaces, stoves, clothes dryers, and other appliances. As a fuel it accounts for 24 percent of our total energy consumption nationwide, all but 1 percent in residential applications. And as we reported last fall ("Drilling Down," September 2011), new fracking techniques are tapping domestic reserves that previously were not economically viable. Vast global supplies are projected to last well into the next century even if natural gas replaces gasoline completely. So it should be no surprise that natural gas will remain incredibly cheap. It runs at one-half to one-third the current cost of gasoline on an energy-equivalent measure. In a properly tuned engine, natural gas combustion delivers 20 percent lower carbon emissions and about a 25 percent reduction in greenhouse gases compared with the cleanest gasoline engines, all without

This is no ordinary minivan. It's a Dodge Caravan converted to run on gasoline and natural gas. The high-pressure fueling line can make fill-ups as fast as gasoline and cheaper too—but things are complicated.

INSIDE

TIRE-PRESSURE MONITORS + BATTERY COMPLICATION + MISSING CRUISE CONTROL



damaging existing catalytic converter systems. So right about now you're probably wondering: Why aren't we putting this stuff in our cars?

As it turns out, there are very few technological barriers to overcome. In fact, converting existing vehicles to burn natural gas isn't particularly challenging. Unfortunately, if you tried to do it yourself, you'd more than likely run afoul of the Clean Air Act's rules against modifying fuel systems—a violation that could cost you up to \$5000 in fines for every day you drive the converted vehicle. So if you want to green your wheels today, the only way to do it is by hiring a certified compressed-natural-gas (CNG) installer to do the job. To get the skinny on aftermarket CNG systems, I visited NatGasCar in Cleveland. It's a startup shop that augments gasoline cars by installing a parallel natural gas fuel system. They showed me their latest creation, a dual-fuel Dodge Caravan intended for airport taxi service. It starts on gasoline and switches over to natural gas once the engine warms up.

NatGasCar's biggest component is also its most crucial and expensive—the compressed-natural-gas fuel tank situated behind the rear seats in the cargo area. The company uses a Type 4 tank, the most advanced kind. It reduces weight with a plastic composite core wrapped in carbon fiber and is rated for severe impact and puncture resistance.

Between the tank and the engine is the fuel regu-

lator, which reduces the fuel-tank pressure of 3600 psi to a usable 125 psi delivered to the engine. The fuel regulator is heated to prevent freezing from the expansion of the gas. The lower-pressure gas travels to the engine, Chrysler's flex-fuel-capable Pentastar V-6. A flex-fuel engine is important, since it has hardened valves and valve seats, which are necessary for CNG operation. The natural gas is routed through a parallel fuel rail, and a second set of injectors is plugged into a clever adapter designed to accommodate both the gasoline and CNG injec-



BITS AND PIECES

UNDER THE HOOD: CNG CONVERSION



LET'S TALK TANKS All CNG tanks must withstand the same standards for impact and puncture resistance as an under-car gasoline fuel tank while also vastly exceeding the strength requirements. There are four types of tanks, each lighter and more expensive than the next. Type I is an all-metal tank, generally steel or aluminum. Type II is a thinner metal tank wrapped around the middle with a fiberglass or carbon composite. Type III is a thinner metal tank fully wrapped in composite. Type IV is a plastic tank fully wrapped in carbon-fiber composite—very lightweight, but it comes at a hefty price.

tors on the same injection port. Natural gas runs at an ideal air–fuel ratio of about 16.8:1, whereas gasoline runs happily at 14.6:1 for the Pentastar engine. As a result, the programming for the new injectors has to be slightly different. NatGasCar’s wiring harness intercepts the signals from the engine-control module and, depending upon which fuel is selected, turns on either the gasoline or the CNG injectors. The signals bound for the gasoline injectors are modified to deliver the appropriate amount of fuel to the natural gas injectors. This way, very little fine tuning is neces-

sary, and the car’s engine-control unit does most of the work.

Fueling Woes

➔ So a new fuel tank and a little bit of tinkering with the fuel injectors and I’m ready to go, right? Unfortunately not.



WHAT YOU'LL NEED FOR A NATURAL GAS CONVERSION

It doesn't take much besides a new fuel tank to convert a gasoline-burning engine to one that also runs on natural

gas. Attached to the fuel tank [1] is the regulator [2], which reduces tank pressure from 3600 psi to 125 psi. Fuel is

then fed to a parallel fuel rail [3] and to new, secondary injectors plugged into an adapter [4]. A wiring harness [5]

plugs into the factory engine-control unit and intercepts throttle information, sending it to a new fueling computer [6],

which slightly alters the data and passes it to the CNG injectors [7] through a parallel wiring harness [8].

Natural gas is delivered across the country to millions of homes. But what would seem to be the ideal distribution network is actually the biggest headache of natural gas vehicles. Home natural gas is delivered at about 0.5 psi, but natural gas in vehicles needs to be pressurized to 3600 psi. So if you want to use CNG in your car, you'll need a compressor. A National Fire Protection Association safety standard bans compressed gas storage in homes, so a stand-alone multistage compressor pump in the garage must be hooked up to the vehicle's fuel tank, filling it directly. This leads to fueling times of up to 22 hours (even longer than equivalent home charging times for electric vehicles). Honda's Civic Natural Gas is paired with a home compressor system called Phill (\$4500), the only commercially available product of its kind. NatGasCar is developing a compressor system capable of 8-hour fill-ups; the current target price is \$3500. Some states have incentivized the installation of high-speed filling systems at gas stations, where fill times are as brief as 4 to 5 minutes, much like gasoline's. But these systems cost \$750,000 per station to install, and low demand means there are only 941 high-pressure CNG filling stations scattered across the country, mostly in New York, California, Utah, and Texas.



Two fuel rails and two sets of fuel injectors feed the same port in the intake. The computer starts the car on gasoline, then switches to natural gas when the engine is warm. The indicator button below is the only clue that this car runs CNG.



Economics

➔ **Okay, okay, it's a pain** to fuel CNG vehicles, but is it worth it? Nationwide, natural gas ranges from 79 cents to \$1.50 for a gasoline gallon equivalent (gge) of fuel. That's considerable savings over petroleum-based products, especially considering that CNG vehicles get the same or better relative fuel economy per Btu because of the higher octane rating of natural gas. Our test drives indicated no hit to performance, and a perfectly acceptable range of about 250 miles. But there are some pretty extraordinary initial setup costs. A properly installed conversion will run anywhere from \$6500 for a basic system to \$12,000 for a top-of-the-line installation with a high-capacity, composite fuel tank. If you want a home fueling compressor, tack on another \$3500 minimum. Even at the low end, you're looking at spending enough on the conversion to buy more than 1800 gallons of gasoline at today's prices.

Those prices will ultimately determine the fate of CNG vehicles. High gasoline prices historically have caused furious investment in cheaper, cleaner fuels, followed by a collapse in demand when gas prices fall. For now, CNG has a high price of entry that makes it viable only for taxi services and other fleet operators, but over time, economies of scale may bring down the costs for the ordinary car buyer. And if gasoline stays above \$3 a gallon, that change may come sooner rather than later. **PM**

CHEMISTRY CLASS

➔ **As the name implies**, natural gas is a naturally occurring fuel source and also a byproduct of petroleum extraction. In its raw state, natural gas can be extracted either pure or as a heady cocktail of methane, ethane, propane, butane, and pentane, as well as nitrogen, carbon dioxide, water vapor, and other compounds. Refineries strip away virtually everything in the mix, leaving methane as the primary component, with a few other compounds added. Methane is the simplest of carbon-based gases: just one carbon atom and four hydrogen atoms. As a result, it's also clean burning, with combustion resulting in one carbon-dioxide molecule and four water molecules, lower greenhouse emissions than any other fuel except hydrogen.

Car Clinic

by *Behr/Mejorian*

Q+A



→ In-wheel tire-pressure monitors have greatly complicated the humble valve stem. The sensor rides inside the tire, constantly testing air pressure and transmitting information wirelessly to the onboard diagnostic system.

A That all depends on what kind of system is installed in your car. Some background: Tire-pressure monitoring systems (TPMS) will become standard starting with all 2012 cars, a result of the Firestone/Ford Explorer rollover fiasco in 2000. These systems are designed to alert drivers to changes in tire pressure while the vehicle is in motion. Despite mandating the monitors, the government didn't set standards for how they should be designed, calibrated, or rolled out to the public, so automakers have developed different measurement methods. One option is indirect, wherein the vehicle's computer compares the ground speed against how fast each wheel is turning. If one tire has less pressure than the others, the outside diameter of that tire will be smaller and thus it will spin slightly faster. The computer algorithm infers the pressure based on the comparative wheel speed. The more widespread, and costly, option is a direct monitoring system, which uses an in-wheel measurement device. These monitors are much more accurate, with an electronic sensor directly measuring tire pressure and transmitting it wirelessly to an onboard detection system.

These variations among systems lead to different

service methods following tire rotation. For indirect systems, the driver doesn't need to do anything except drive around; the vehicle automatically figures out the pressure. For direct monitoring systems, there are three ways to reassign each tire to the correct corner. Typically, high-end cars do it automatically—convenience is a luxury, right? The second way is not so convenient: Take the car to the dealer so its wrench jockeys can use an electronic calibration

Under Pressure

I'm going to be rotating the tires on my 2011 Chevy Malibu, and since this will be my first time doing it, I'm wondering about

the tire-pressure monitoring system. Are there any special steps I need to take so the correct readings come up on my display?

PHOTOGRAPH BY MICHAEL NEMETH

DIY

Auto CAR CLINIC Q+A

tool to do the job. Now we get to your situation. Most GM cars—such as your Malibu—use a teach-and-learn method. (Other manufacturers use similar methods, but each has its own variations—for some, there are even magnets involved. It's best to consult the owner's manual or ask the dealer about how it's done.) After you've rotated your tires, put your car into learn mode by going into the vehicle setup screen on the dashboard. Select the tire-pressure-monitor reset. Next, following the directions on the driver information center, start at the left front tire and deflate only a few psi; this forces the sensor to send an identifying signal to the system. After the computer has reassigned the tire, move in a clockwise direction around the car, reassigning the sensors in the same manner.

Assault With Battery ➔

I have a 2007 BMW 525i that has about 65,000 miles on it. It won't

be long until I need to replace the battery. The dealer says that I should let him do it so he can reset the computer's charging circuit. He says if I replace it myself, the battery won't charge properly. Can I do this myself and somehow reset the computer?

Believe it or not, your dealer isn't pulling your leg, at least not much. Your BMW, being "the ultimate driving machine," actually tracks the battery's charge and discharge cycles and predicts its usable life. When the car's computer decides that a battery is up for replacement, the driver gets a warning that can't be cleared unless a new battery is installed and the car is hooked up to a service tester at the BMW dealer. This registration process records the car's age and mileage and resets the battery-life monitor. This isn't to say you can't simply swap the battery yourself—you absolutely can—just know that the warning light will never go away and you'll be

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responsible for tracking when to replace the battery. For you non-BMW owners, or BMW cheapskates, be sure to keep a tally on the age of your battery. It should be changed about every four years, as the internal chemical compounds degrade over time.

Grease Monkey 🍌 Driving my '04 Grand Prix, I keep my arm on the plastic ledge by the window rather than on the armrest. It's resulted in an oil buildup on the ledge. What's the best way to get this off without hurting the interior?

My first suggestion is, of course, to wash your arm more often. With that out of the way, I recommend a two-part process to remove the buildup, which is common on plastic, vinyl, and leather in well-used cars. Much of the film can be removed with plain soap and water and a washcloth. This won't get you to a squeaky-clean, properly protected finish, though. Anything in an auto store's potions aisle labeled as a cleaner and protectant will remove the remaining residue and leave behind a plastic-moisturizing conditioner to bring back the finish to almost showroom-new.

Vacationing Cruise 🍌 I own a 2001 Ford Explorer XLS. Last night I drove to a restaurant using the cruise control, and it worked fine. When I left the restaurant, I noticed the cruise was out of commission. The Speed Control light came on as if it were working, but it never kicked in to maintain speed. Any ideas about what might be going on?

First and foremost, if your Explorer is

equipped with the 4.0-liter V-6, it was subject to a recall on the speed-control system because the control cables would bind and cause a slow return to idle when cruise was defeated. Make sure that recall has been taken care of before you go any further. As to your specific problem, it sounds like the cruise-control servo is the culprit rather than the computer. The servo motor is the electronic component attached to the throttle with pushrods or cables that hold the throttle in place when cruise control is active. Since the onboard diagnostic system isn't reporting a problem, it's likely the signal from the computer isn't producing the correct result from the cruise-control servo motor. Take a quick look at the part before replacing it, though. Sometimes cleaning and lubricating can correct this kind of problem.

PM

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This Is My Job

X When he was a kid, Chris Southerly wanted to try scuba diving—but the mountains of Virginia, where he grew up, offered few opportunities. So Southerly learned to dive in grad school, and now it's how he makes his living: As an underwater archaeologist for North Carolina's Department of Cultural Resources, Southerly is currently excavating the infamous pirate Blackbeard's flagship, *Queen Anne's Revenge*, near Beaufort Inlet, N.C. When he's not diving to the wreck, he's examining artifacts from the ship to figure out how they fit into people's lives. "An artifact is a tangible connection to our history," he says. "It's one thing to read about it in a book. It's a whole other experience to hold it in your hand knowing that you're the first person to see or touch this object in nearly three centuries." — MARY BETH GRIGGS



PHOTOGRAPH BY NATHAN PERKEL

× UNDERWATER ARCHAEOLOGIST

Name: CHRIS SOUTHERLY
Location: WILMINGTON, N.C.
Age: 44
Years on Job: 11

ESSENTIAL EQUIPMENT

FULL FACE MASK

→ "In many cases the waters we're working in have zero visibility," Southerly says. To communicate with fellow divers and the surface crew, he uses scuba gear with a full face mask. Unlike typical scuba equipment, which requires a diver to breathe through a mouthpiece, the mask allows Southerly to talk to other divers up to 150 feet away via a radio link.

PORTABLE MAGNETOMETER

→ After using sonar to identify a site, archaeologists deploy portable magnetometers that detect the presence of iron under layers of sediment to pinpoint the best spots for excavation. "Detecting range is based on distance from the object and the magnetic disturbance it causes," Southerly says. "A cannon might be detectable from 15 feet, while a cannonball may only be detectable from 5 feet."

HAMMER AND STAKES

→ "Archaeology is a destructive science," Southerly says. "Once we dig it up, we can never put it back the way it was." Without context, artifacts are nearly worthless, so archaeologists document the site meticulously. Using stakes and synthetic decking boards, they create a 5 x 5-foot grid on the seafloor, then map the location of the artifacts on waterproof paper.

SLUICE

→ Southerly uses a suction tube to remove small items from the wreck to a sluice, or artificial water channel, on the ship's deck. Sand and mud flow with the water until they are discharged at the end of the sluice, while heavier artifacts, such as nails or shotgun pellets, drop out of the flow into a separate channel, where they're identified and labeled. Larger items are hoisted up with an electric winch after they've been tagged and mapped on the seafloor.

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